april 1959

nlgi spokesman

journal of the national lubricating grease institute

Comparison of Temperature Effects on the Flow Properties of Greases in Capillary and in Cone and Plate Viscometers

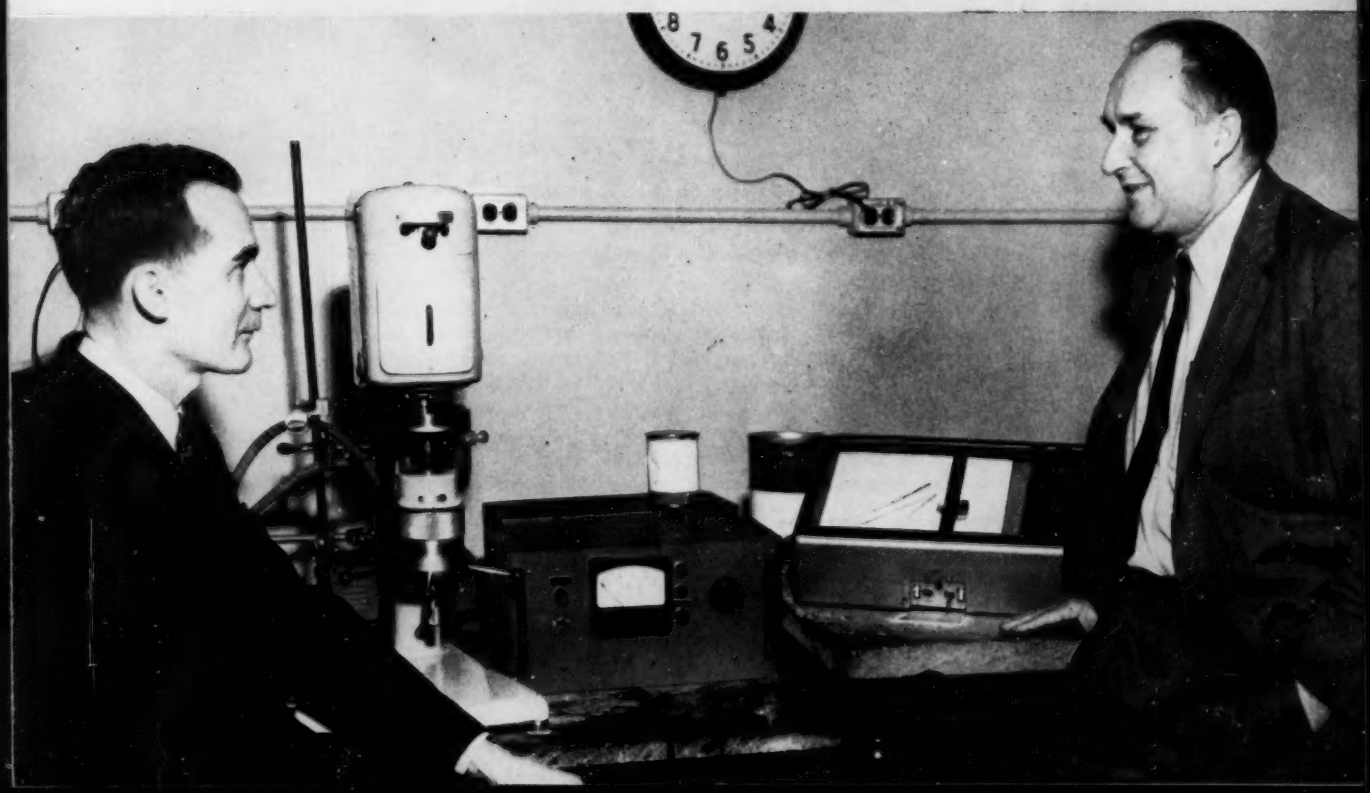
By W. H. BAUER, A. P. FINKELSTEIN, D. O. SHUSTER AND S. E. WIBERLEY

Recent Developments and Trends in Industrial Gear Lubricants

By E. S. REYNOLDS

Facts and Factors in Grease Manufacturing Costs

By M. S. MINGLEDORFF



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Leach tanks handling hot slurry, agitators driven by Falk gear reducing units.

V.A. Wemco classifier, part of wet grinding system, lower bearing submerged in hot sludge.

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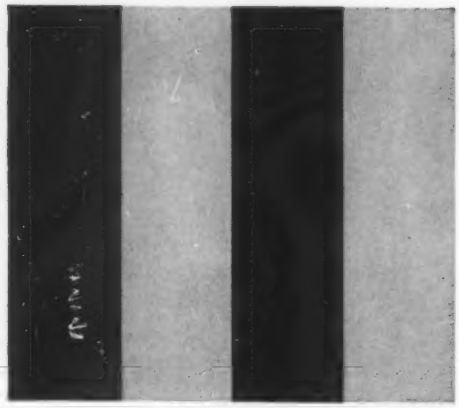

News About NLGI

Concentrate on Oil Drain and Lube Interval

Concerning the drive by the industry to tell motorists the "how and why" of proper oil drain and lube job intervals, the NLGI board of directors has previously indicated a desire to work in close con-

California Standard Billboard

junction with the lubrication committee of the marketing division, American Petroleum Institute. At its recent meeting in Detroit, the governing body of the Institute agreed to tie in with results of certain lubrication committee activities, once they have been formally announced . . . then to work in cooperation with the API group.

Chairmanned by R. Cubicciotti, a supplementary API program is being conducted to reach the consumer with individual company advertising. Firms are carrying promotions via all media (see cut, for one) and the tempo is quickening in lube advertising. One NLGI member, Western Oil of Canada, has even modified its trade mark to stress the need for lubrication . . . as shown above.

Cubicciotti, immediate past president of NLGI, is compiling various techniques and approaches in selling the consumer on lubrication. This information is sent out in bulletins to stimulate the drive on a much needed aspect of motoring today.

Second Survey Data To Be Released Soon

As this is being written, statistics for the second annual survey on production of lubricating greases and fluid gear lubricants are being compiled by the gathering agency. Production totals for the 1958 calendar year were rendered by NLGI Active (manufacturing) member firms to the management services division of Ernst & Ernst, nationwide certified public accountants.

The first survey, on 1957 production, showed over one billion pounds of lubricants produced. The 1958 survey was enlarged to include Canadian members and expectations are that total representation shown will exceed the 76 per cent of members who replied to the first survey . . . it was estimated unofficially that 85 per cent of production was shown in the 1957 data.

All classifications of membership in the Institute will receive copies of the survey results immediately upon receipt by the national office.

NLGI Film Prices Reduced by Board

The purchase price on the NLGI movie, "Grease—the Magic Film" has been reduced!

That's the big news to come out of Detroit after the NLGI board of directors meeting there in February. Not only will original prints be marked down but second prints will cost less, too. First prints will be reduced from $600 to $300, while second and all subsequent prints will be reduced from $400

Continued on page 4

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- ATTRACTIVE STOCK LITHO
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CLEAN WHITE APPEARANCE

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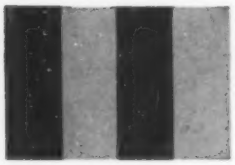
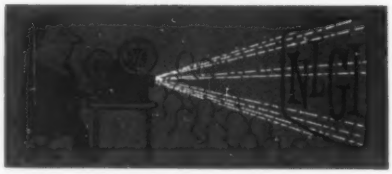


News About NLGI—Cont'd

to $200. Non-members will pay $100 more in both categories.

A number of reasons motivated the Institute's governing body in the lower price decision . . . original print owners have had considerable employment of their films and NLGI's subsidy proved to be less than originally expected, due to a volume of sale that had not been anticipated in the early planning stages of "Grease—the Magic Film." World wide distribution was quickly attained and showings are constantly being scheduled by members of the industry, for the public evidenced an interest in the picture. With a lower price structure the board of directors hopes to educate even a larger share of the motoring public and to counter certain misconceptions about the advisability of frequent lubrication.

The 16-mm color film has been shown to a number of varied au-



diences since it was first previewed in Chicago year before last. Sales training, public relations, customer information . . . the list of uses goes on and on. In 26 minutes the lubricating grease story unfolds in an entertaining and informative manner—music and narration blending with animation and action photography.

Members and friends of NLGI may still obtain copies of the film from the national office in Kansas City, for previewing purposes. These prints are shipped without obligation and should a firm decide to purchase their own copy, delivery can usually be made within two weeks of receipt of order.

Many Film Uses

"We find that by showing 'Grease—the Magic Film' first—before giving our salesmen a tour of the plant, we almost double their understanding of the subject." That was the advice given NLGI by one sales manager who employs his copy of the film in sales training.

"People become emotionally involved in a subject if they see and hear a film about it," advised another print owner. "We use our copy of the picture to overcome the public's misconceptions . . . to sell on the need for grease."

SERVICE AIDS

Send Orders to: National Lubricating Grease Institute, 4638 Nichols Parkway, Kansas City, Mo.

REPRINTS — From the NLGI SPOKESMAN are available at low cost. Page forms are left standing for three months, company imprint or advertising arranged.

WHEEL BEARING MANUAL—"Recommended Practices for Lubricating Automotive Front Wheel Bearings." More than 120,000 copies of this booklet have been distributed throughout the world. Fifteen cents a copy (NLGI member price) with quantity discounts — company imprint arranged.

VOLUME XXI—Bound volume of the NLGI SPOKESMAN from April, 1957 through March, 1958. Contains 34 articles and features dealing with lubricating greases and gear lubricants . . . $7.00 (NLGI member price) and $10.00 (non-member) plus postage.

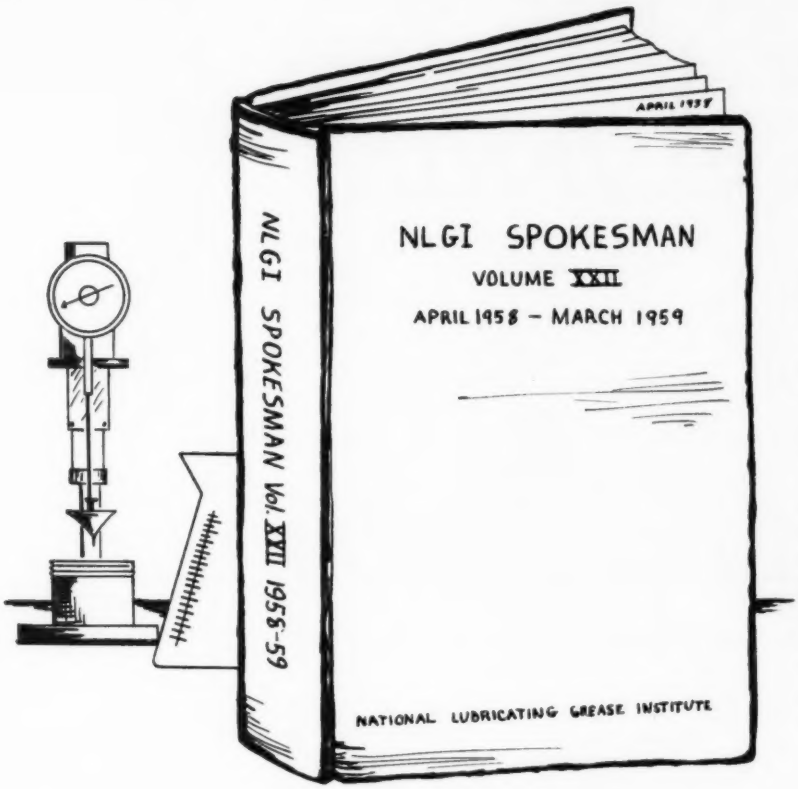
VOLUME XXII—Bound Volume of the NLGI SPOKESMAN from April, 1958, through March, 1959. Contains 31 articles and features dealing with lubricating greases and gear lubricants . . . $7.00 (NLGI member price and $10.00 (non-member) plus postage.

NLGI MOVIE — "Grease, the Magic Film," a 16-mm sound movie in color running about 25 minutes, now released. First print $300, second and subsequent orders $200 each (non members add $100 to each price bracket).

BONER'S BOOK—Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. $18.50, prepaid.

VOLUME XXII

Now available for your—



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SHELL ALVANIA GREASE is available world-wide . . . assurance that your customers abroad will get the same performance from your equipment that domestic customers rely upon.

You can count on Alvania® Grease to remain plastic in sub-zero weather and, equally important, to remain stable under sustained high temperatures. On job after job, Shell Alvania Grease has successfully replaced dozens of special lubricants.

Alvania Grease also has an outstanding performance record on the toughest anti-friction bearing grease applications. It is ideal for wet, humid applications because it is inhibited to prevent water corrosion. It gives good lubrication under conditions which normally spell trouble.

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the truly multi-purpose lubricant

SHELL

nlgi spokesman

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THE COVER

Dr. W. H. Bauer and Dr. S. E. Wiberly are shown on the cover picture in the flow laboratory of the Rensselaer Polytechnic Institute at Troy, N. Y., where the work, co-authored with Mr. D. O. Shuster and Mr. A. P. Finkelstein on "Comparison of Temperature Effects on the Flow Properties of Greases in Capillary and in Cone and Plate Viscometers" was done. This paper which begins on page 15 was given at the 26th Annual Meeting of NLGI in Chicago, Oct., 1958, and is the first of a series of fundamental research papers which the SPOKESMAN will feature in future issues of the Institute's journal.

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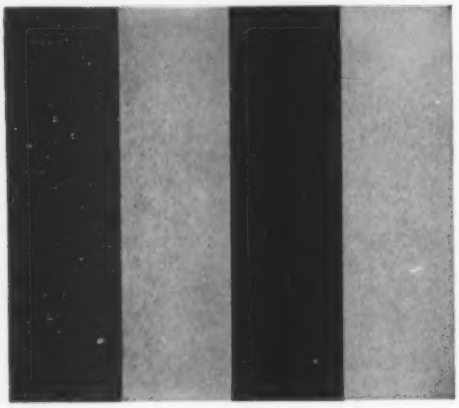

NLGI PRESIDENT'S PAGE

By F. E. ROSENSTIEHL, *President*

Thinking Twice About Grease

In an age of continual technological advance, perhaps it is inevitable that we soon take for granted, or lose our wonder at, those things that have become a familiar and dependable part of our daily life. Who, for example, stops to wonder about the miracle of the telephone, the airplane, or television – or even among our own members, of the apparently humble and yet very complex substance – grease?

Yet the development of modern greases, with their almost infinite range of qualities and functions, has itself been something of a technological marvel. Today's greases must meet operating conditions undreamt of even fifty, or forty – or some, even ten years ago. They must function in the brittle and sub-zero temperatures of –100°F. or in searing heats that may reach 500°F. Some must shed water while others absorb it without loss of either consistency or function. At times greases must stream through long-distance lines and flow around bearings almost like water itself, and at other times, they must gell around surfaces to ward off dirt and grime. Yet they must always lubricate, saving bearing surfaces against the toll of friction.

In effect, almost every advance in technology is also a challenge to the grease industry. Tomorrow's greases will probably have to withstand even higher temperature and more strenuous shear–certainly they will have to perform under the often destructive rays of nuclear radiation.

Far from commonplace, today's and tomorrow's lubricants continue to be part of the wonder and challenge of this complex and changing industrial world. I should like to believe that this is part of the value of the NLGI and its open discussion forums – to make us stop and think twice, to provoke the wonder necessary to progress and to life.

Greases made with

BARAGEL*

... lower equipment maintenance costs!

Maintenance costs are held to a minimum . . . on all types of equipment . . . when lubricated with greases made from BARAGEL.

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Future Meetings

APRIL, 1959

5-10 American Chemical Society 135th National Meeting.

15-17 National Petroleum Association, Semi-annual Meeting, Hotel Cleveland, Cleveland, Ohio.

21-23 ASLE Annual Meeting and Exhibit, Hotel Statler, Buffalo, New York.

27th Annual Meeting

NATIONAL LUBRICATING GREASE INSTITUTE

October 26, 27, 28, 1959

Roosevelt Hotel

New Orleans, Louisiana

MAY, 1959

4-6 API Division of Marketing, Lubrication Committee Meeting. San Marcos Hotel, Chandler, Ariz.

15-24 International Petroleum Exposition.

27-29 API Division of Marketing, Mid-year Meeting. The Savery, Des Moines.

31-June 6 Fifth World Petroleum Congress. The Coliseum, New York City.

JUNE, 1959

1-5 Fifth World Petroleum Congress Exposition, The Coliseum, New York City.

8-9 Petroleum Packaging Committee Meeting, Cleveland, Ohio

14-19 SAE Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

21-26 ASTM Annual Meeting Chalfonte-Hadden Hall, Atlantic City, N. J.

OCTOBER, 1959

26-28 NLGI Annual Meeting, Roosevelt Hotel, New Orleans, La.

11-15 ASTM Committee D-2 Meeting, Sheraton - Palace Hotel, San Francisco.

12-13 Petroleum Packaging Committee Meeting, Port Arthur, Texas

19-21 ASLE and ASME Joint Lubrication Conference, Sheraton-McAlpine Hotel, New York City.

28-30 Society of Automotive Engineers, National Fuels and Lubricants, La Salle Hotel, Chicago.

NOVEMBER, 1959

9-11 API, 39th Annual Meeting, Conrad Hilton, Palmer House and Congress Hotels, Chicago

APRIL, 1960

19-21 ASLE Annual Meeting and Exhibit, Netherland-Hilton Hotel, Cincinnati, Ohio.

APRIL, 1961

11-13 ASLE Annual Meeting and Exhibit, Bellevue Stratford Hotel, Philadelphia, Pa.

OCTOBER, 1961

30-Nov. 1 NLGI Annual Meeting, Edgewater Beach Hotel, Chicago, Illinois.

4-6 API division of Marketing, Lubrication Committee Meeting.

15-17 National Petroleum Association, Semiannual Meeting.

26-27 API Division of Marketing, Lubrication Committee Meeting.

27-29 API Division of Marketing, Midyear Meeting.

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790 LOAD-A-PAK WHEEL BEARING PACKER

6000 LOAD-A-PAK Special WHEEL BEARING GREASE

They are Made for Each Other...

At last, a simple, easy-to-use, priced right, and most important of all, cartridge loaded, Wheel Bearing Packer. The Load-A-Pack was designed with you in mind. With the all-new, 24-oz. No. 6000 Load-A-Pack cartridge, it is the clean, quick, and easy "fill-and-use" wheel bearing packer.

Load-A-Pak Cartridges packed 40 per carton and 20 per carton

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Manufacture and Application of

LUBRICATING GREASES

by C. J. Boner

Chief Research Chemist
Battenfeld Grease and Oil Corp.

1954
982 pages
$18.50 prepaid

982
FACT-FILLED PAGES
IN THESE
23
BIG CHAPTERS

1 Introduction
2 Structures and Theory
3 Additives Other Than Structural Modifiers
4 Raw Materials
5 Manufacturing Processes
6 Equipment for Lubricating Grease Manufacture
7 Aluminum Base Lubricating Greases
8 Barium Base Lubricating Greases
9 Calcium Base Lubricating Greases
10 Lithium Base Lubricating Greases
11 Sodium Base Lubricating Greases
12 Lead Soap Lubricating Greases
13 Strontium Base Lubricating Greases
14 Miscellaneous Metal Soaps as Components of Lubricating Greases
15 Mixed Base Lubricating Greases
16 Complex Soap Lubricating Greases
17 Non-Soap Thickeners for Lubricating Fluids
18 Fillers in Lubricating Greases and Solid Lubricants
19 Residua and Petrolatums as Lubricants
20 Analysis of Lubricating Greases
21 Tests of Lubricating Greases and Their Significance
22 Application of Lubricating Greases
23 Trends in Lubricating Greases

Here in one giant volume . . . the most complete storehouse of information ever published on the composition, properties and uses of lubricating greases!

The book begins by describing in detail the structure and theory of lubricating greases. Then follow chapters on the various raw materials, processes and manufacturing equipment. Lubricants containing specific thickeners, including such recent developments as lithium soaps, complex soaps and non-soap gelling agents, receive special attention.

Of major interest is the large section on present uses and future trends of lubricating grease products. Here you'll find the complete details of when, where, and how to apply a specific lubricant for any given purpose.

Everyone concerned with the preparation or use of grease lubricants will find Boner's book of enormous practical value. Manufacturers and lubricating engineers will find here a complete breakdown of the effects of each ingredient of treatment upon the characteristics of the final product, and a full explanation of the physical and chemical methods used in measuring these characteristics. Suppliers of fats, oils, additives, thickeners and other raw materials will gain new ideas for future product research and development. In addition, users of grease products will learn the properties of available lubricants and the major purposes that each fulfills.

MAIL THIS HANDY ORDER COUPON TODAY!

NLGI SPOKESMAN
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Please rush me a copy of Boner's MANUFACTURE AND APPLICATION OF LUBRICATING GREASES.

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Another packaging advance by Continental

the new HI-STACKER

utility can with reversible spout

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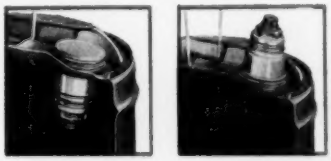
- *Simple to palletize*
- *I.C.C. approved*

Continental's new, Dome-top Hi-Stacker makes every inch of shipping, storage and display space count. It's easy to fill, easy to handle. Filler openings are available to fit your requirements. For further details, ask your Continental man.

REVERSIBLE SPOUT RIDES SAFELY, ATTACHES EASILY



Spout remains inverted during shipment and storage. To pour, spout is reversed — ready for fast, smooth dispensing. Spout remains in fixed position until container is empty.

Looks like Continental's famous Dome-top utility can (at left). Has all its sales features. Completely redesigned to save space and money.

CONTINENTAL CAN COMPANY

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Central Div.: 135 So. La Salle St., Chicago 3
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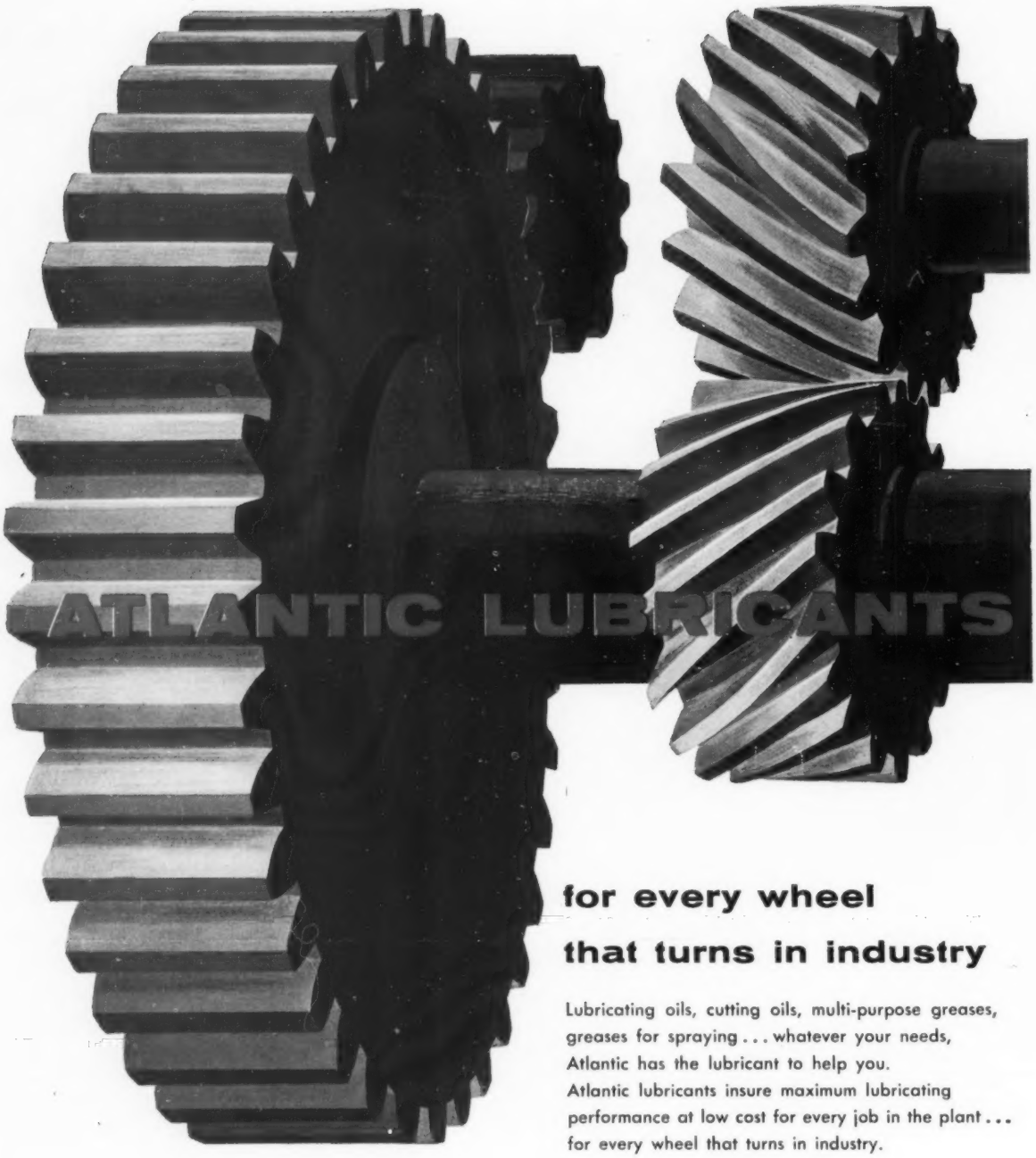

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Comparison of Temperature Effects on The Flow Properties of Greases in Capillary and in Cone and Plate Viscometers

By:
W. H. Bauer
A. P. Finkelstein
D. O. Shuster
S. E. Wiberly

Rensselaer
Polytechnic
Institute

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Abstract

The effect of temperature changes on the initial resistance to flow under stress has been studied for typical greases, with an automatically speed controlled cone and plate viscometer, recording shearing stress versus shearing rate. Flow properties of greases obtained with a capillary viscometer are compared with those measured by means of a cone and plate viscometer. Energies of activation for viscous flow calculated from the apparent viscosities obtained from capillary flow data differ from those calculated from the apparent viscosities given by the cone and plate viscometer. Results indictate that various structural elements in the grease have different temperature coefficients of resistance to flow, and that the extent of destruction of such elements is markedly different in the two types of viscometers.

Introduction

According to structures recently proposed,[1,2] in greases a network of fiber is filled with trapped lubricating oil. Structural elements leading to flow resistance in greases are fiber interaction at ends and points of contact, fiber-oil interactions arising from Van der

Waals' forces, and the stability of the fibers with respect to rupture, depending upon ionic and Van der Waals' forces within soap fibers. In addition, the flow rate of grease on application of shearing stress is affected by the viscosity of the oil present in the structural network of fibers. On continued shear during flow of grease, flow resistance due to the structure is changed as a result of rupture of fibers, alignment of fiber particles in flow, removal of immobilized oil from fiber surfaces, and separation of fiber ends and contact points. At the same time, the viscosity of the trapped oil remains unchanged at constant temperature. Since temperature change would affect the component of grease viscosity arising from structural Van der Waals' forces differently than it would affect the viscosity of the base lubricating oil the temperature coefficient of flow of grease should depend on the shear history. Examination of temperature effects on flow of grease after controlled shear should therefore be of interest.

Capillary viscometers have been widely used in the study of flow properties of greases.[3] In such instruments, grease entering the capillary tube is subjected to varying rates of shear throughout the volume approaching and entering the capillary.[4] As the grease moves along the tube in flow, the rate of shear varies from a minimum in the center region to a maximum at the wall. The breakdown of structural viscosity in the stressed sample is thus not uniform in the volume of flow, and only the nominal rate of shear can be measured from the flow rate. Only after the structural elements in the grease have reached an equilibrium and uniform extent of destruction, after repeated passage or passage through a very long tube, can the capillary viscometer give flow information on a grease sample of uniform shear history.

The effect of capillary length to diameter ratio on the flow curves of grease A in this investigation is illustrated in Figure 1. While the ASTM viscometric method,[5] requiring a length to diameter ratio, $\frac{L}{D'}$, of 40 minimizes to some extent the entrance effects, it is evident from Figure 1 that grease A does not reach flow uniformity or equilibrium in a capillary tube of that ratio. Difference methods, in which flow results for two capillaries are subtracted to give a pressure drop per unit length, will give corrected values only if the flow is compared for two capillaries of very high $\frac{L}{D'}$ ratio in case entrance effects are considerable.

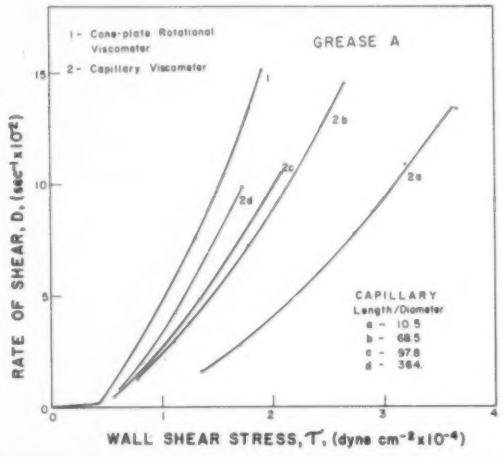


FIGURE 1, flow curves of lithium base grease A at 25°C. Curve 1 obtained in 150 sec in cone-plate viscometer with increasing rate of shear after initial cycle of shear of 300 sec reaching a rate of shear of 1500 sec^{-1}.

For grease A, when the pressure drop, P, required to give a specified flow rate, Q, in capillaries of constant bore is plotted against tube length, as in Figure 2, the

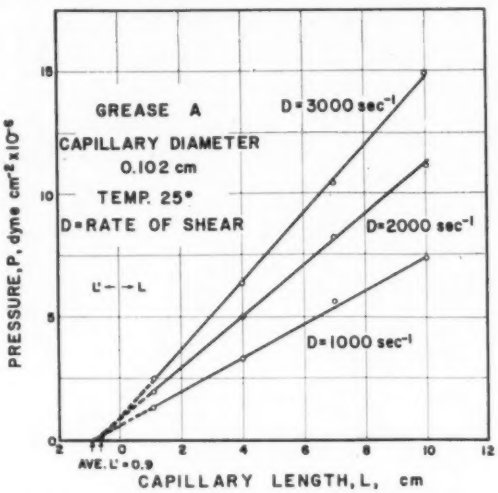


FIGURE 2, pressure required to give specified flows in capillary tubes of various lengths and constant diameter for grease A at 25°C.

lines obtained extrapolate not to zero pressure at zero length, but to a point L′ beyond zero length. Thus the effective length for a tube of length L is $L + L'$ and a corrected wall shearing stress, $\tau_c = R\left[\frac{P}{2\left[\frac{}{L+L'}\right]}\right]$. Even if sufficient information obtained with tubes of various dimensions is available to correct the flow information for entrance effects, the factor of time in transit of the grease in the capillary tube may make invalid comparisons between flow measurements in capillary viscometers. As shown in Figures 3 and 4, where shear rate, D, is plotted versus shearing stress, τ, for two greases, the time of shearing[6] as well as the rate of shear may affect the apparent viscosity, $\frac{\tau}{D}$. Only in tubes of extremely large $\frac{L}{D'}$ ratios would greases of the types illustrated reach a state of equilibrium with respect to accumulated shear or working. Use of tubes

for which $\frac{L}{D'}$ is very large, however, introduces difficulties because of the essentially adiabatic[7] passage of the sample in capillary flow, resulting in increases in sample temperature. Because of such temperature effects, Singleterry and Stone[4] recommend that $\frac{L}{D'}$ be no longer than 10.

It is thus apparent that if it is desired to make flow measurements isolating the effect of temperature changes difficulties will be found in procuring data for samples of comparable uniform shear history when capillary viscometers are employed.

Rotational viscometers, in which the test sample remains in the instrument during continued study, appear to have many advantages. As reported by Weltmann,[8] defined shear conditions are more readily obtained, since the gradient of shear rate is small across the small thickness of the sample between the inner and outer cylinders and since temperature control of the sample is more effective. Because the sample under test is not renewed during measurement, its shear history is defined. Change of flow properties may be obtained on a programmed application of shear rate. Samples may be studied after reaching equilibrium at a given shear rate. However, in the concentric cylinder instruments presently available, rise in temperature of the sample during continued shear, especially at high rates of shear, may seriously affect flow measurement. In this respect, especially, improvement is gained by the use of a recently developed[9] rotational type of viscometer in which the moving mechanical element is a low angle cone immersed in a thin film of sample on a stationary plate. Because of the close contact between sample and metal, heat generated in flow is more readily dissipated to the temperature controlled plate than is possible for the thicker samples used in conventional concentric cylinder instruments.[10] With proper automation of programming of shear rates and appropriate recording facilities, it appeared that some of the disadvantages of capillary viscometry might be overcome. The clear delineation of initial yield value and limiting flow curve after shear given by a cone-plate viscometer are shown in Figure 1 for grease A, where flow curves for various capillary tubes are compared. A comparison of temperature effects on flow properties in the capillary tube and in the cone-plate types of viscometers was therefore undertaken.

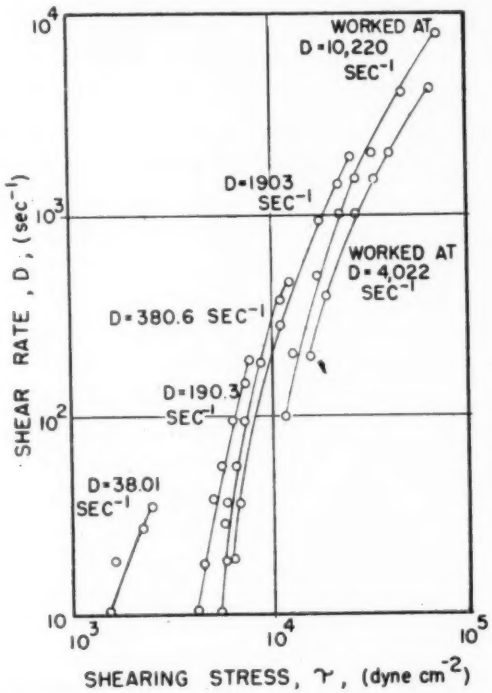


FIGURE 3, flow curves for a calcium complex grease at 25°C, obtained with cone-plate viscometer after 2800 seconds at indicated rates of shear, logarithmic scales.

Experimental

Cone-plate viscometer

The instrument used in this work[9] was a Ferranti-Shirley No. F-S-12, in which a low clearance cone is immersed in a sample of fluid, approximately 0.1 cc. on a temperature-controlled base plate with temperature sensing thermocouples imbedded in insulating material, in contact with the sample. Speed of rotation of the cone is set by the voltage furnished to a D.C.

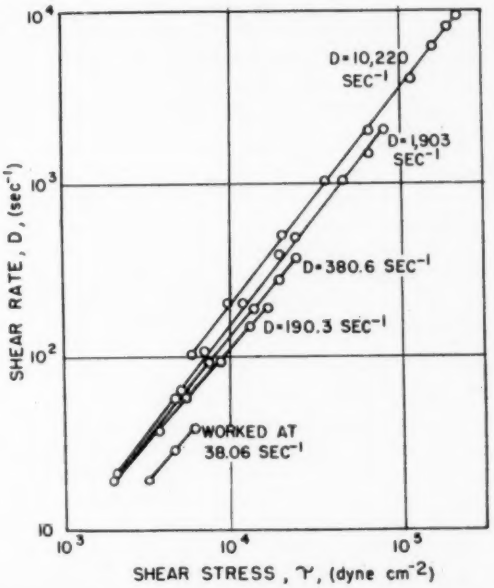


FIGURE 4, flow curves for an aluminum soap grease at 25°C, obtained with cone-plate viscometer after 2800 seconds at indicated rates of shear, logarithmic scales.

drive motor from a feedback controlled generator. The angle of the cone is such as to subject the sample to uniform rate of shear and shear stress, according to the design of Mooney and Ewart.[11] Rate of shear was controlled by an automatic programming device which raised the rate of shear at a uniform rate to a predetermined value and returned the rate of shear to zero. Voltages from shear stress and rate of shear transducers were brought to an x-y recorder, and flow curves were directly plotted. The instrument was calibrated against Bureau of Standards oils of known viscosity in the temperature range studied at each time of measurement. Temperatures registered by the thermocouples were checked at 0° and 37.8° by use of the Bureau of Standards oil of known viscosity in the temperature range. For tests of the effect of continued shear, the rate of shear could be raised automatically to a desired value and maintained while shear stress was recorded versus time.

Capillary viscometer

A capillary viscometer with floating driving piston and interchangeable capillaries was used.[12] Viscometer capillary tubes were mounted flush with the surface of the base plate of the viscometer in a standard taper opening. The viscometer reservoir tube, 1.5″ in diameter and 10″ long, was connected to a source of compressed nitrogen providing the driving pressure. The volume rate of flow of the gel through the capillary tube was calculated from the rate of descent of the driving piston and its cross sectional area. Rate of movement of the piston was automatically followed by means of a graduated rod attached to the piston, for which the movement was recorded by a transducer as voltage impulses versus time. The viscometer was calibrated against Bureau of Standards oils, and from the capillary dimensions determined by measurement. Capillaries were of glass, checked for uniformity of bore.

Materials

Greases used were commercially prepared, currently produced products, taken from the container as furnished by the manufacturer. Samples were transferred to the test apparatus with the least disturbance possible. Greases A and C had a lithium base, grease B had a sodium base, and grease D had a calcium base.

Experimental Results

Cone-plate viscometer flow measurements

In tests with the cone-plate viscometer, grease samples were carried through a first cycle, I, of accelerating rate of shear to a maximum, after which the rate of shear was uniformly decreased to zero. After a period of rest on the viscometer plate at the test temperature, a second cycle of shear, II, was applied to the same sample. The results of the flow measurements are shown in Figures 5a through 8c. The samples of grease were subjected to the effect of constantly accelerating speed of rotation of the drive shaft, connected by a torque spring to a shaft which terminated in the cone immersed in the test sample of grease. It was observed that the cone remained stationary in contact with the grease sample after start of acceleration of the drive shaft, until such a torque had been developed that a yield value was exceeded. Upon development of greater torque, flow of the grease and rotation of the cone commenced. The speed of rotation of the cone then rapidly approached that of the drive shaft, following closely the subsequent acceleration and deceleration of the drive shaft during the test cycle.

An analysis of conditions during the measurement of the yield value shows the following relations. The speed of rotation of the drive shaft in radians per sec, $\frac{d\theta}{dt}$, is increased from zero to a maximum value with constant acceleration. Thus

$$\frac{d^2\theta}{dt^2} = k$$

$$\frac{d\theta}{dt} = kt$$

and θ, the accumulated rotation in radians at a time of t seconds is given by

$$\theta = \frac{kt^2}{2}$$

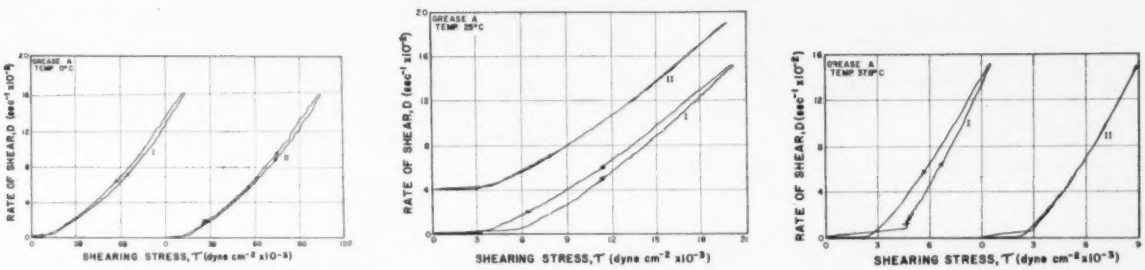
From this relation, the angle of rotation, θ_0, of the drive shaft when yield occurs may be calculated from the observed elapsed time, t_0, when motion of the cone immersed in the sample commences, following start of the drive shaft rotation. At any time the angle of separation of the drive shaft and the cone shaft, θ', is a function of the measured shear stress, τ, and, α, the radians rotational extension of the torque spring per dyne cm^{-2} stress developed. Thus the angle of separation of the drive shaft and the cone shaft at the time of yield, θ'_0, may be calculated from the yield stress, τ_0, from

$$\theta'_0 = \tau_0\alpha.$$

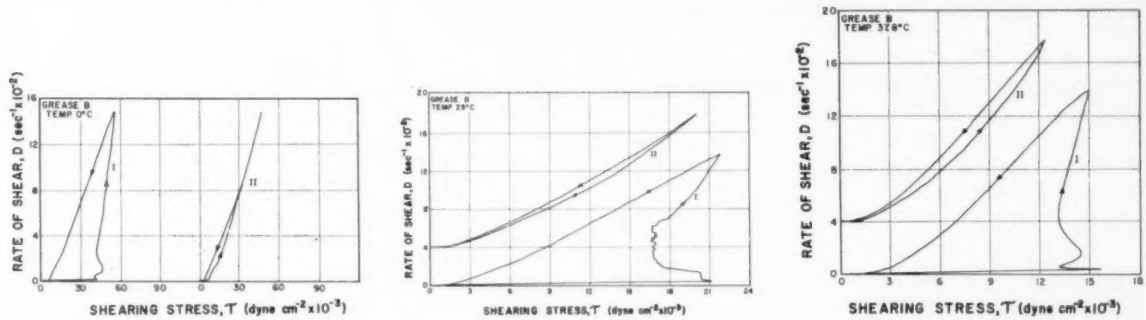
When the values of the angle of rotation of the drive shaft and the angle of extension of the torque spring were compared, it was found that $\theta_0 = \theta'_0$ for the greases tested, within the limits of accuracy of the experiments. It was thus indicated that no flow occurred until the yield stress was exceeded, and that true yield values were measured. No elastic deformation was detected. For grease A at 25°C in a cycle for which $k = 5.56 \times 10^{-2}$ radians sec^{-2} and $\alpha = 9.82 \times 10^{-5}$ radians per dyne cm^{-2}, typical results were as follows:

$\tau_0 = 5.3 \times 10^3$ dynes cm^{-2}
$t_0 = 4.2$ sec
$\theta_0 = 0.49$ radians
$\theta'_0 = 0.52$ radians

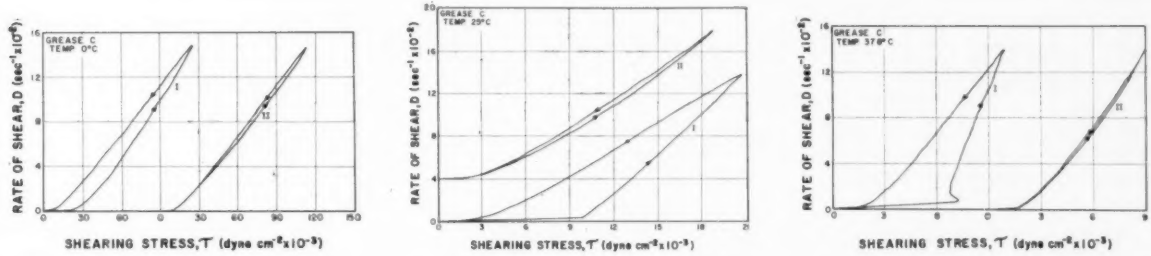
In the experiments for which results are shown in Figures 5a through 8c, the maximum rate of shear attained in the cycles was held to approximately 1500 sec^{-1}, because up to this rate of shear the temperature



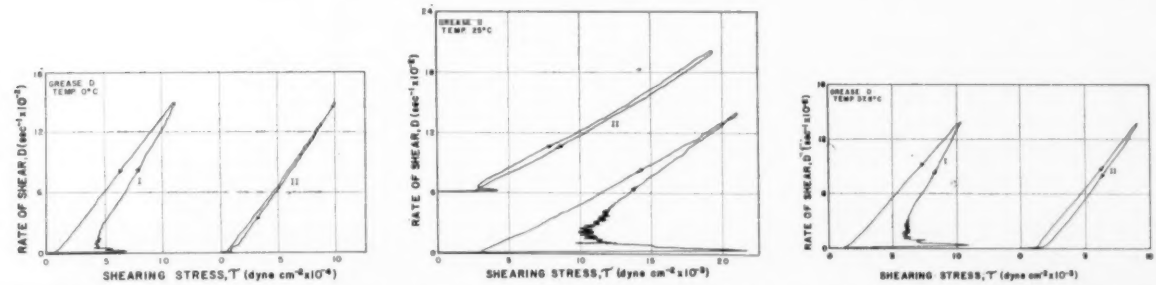
FIGURES 5a, 5b, 5c, flow curves of grease A, obtained at 0°, 25°, and 37.8°C, with cone-plate viscometer. Cycle I was carried out in 300 seconds, followed by a rest period of 15 minutes and cycle II, 300 seconds.



FIGURES 6a, 6b, 6c, flow curves of grease B, obtained at 0°, 25°, and 37.8°C, with cone-plate viscometer. Cycle I was carried out in 950 seconds, followed by a rest period of 30 minutes, and cycle II, 950 seconds.



FIGURES 7a, 7b, 7c, flow curves of grease C, obtained at 0°, 25°, and 37.8°C, with cone-plate viscometer. Cycle I was carried out in 950 seconds, followed by a rest period of 30 minutes, and cycle II, 950 seconds.



FIGURES 8a, 8b, 8c, flow curves of grease D, obtained at 0°, 25°, and 37.8°C, with cone-plate viscometer. Cycle I was carried out in 950 seconds, followed by a rest period of 30 minutes, and cycle II, 950 seconds.

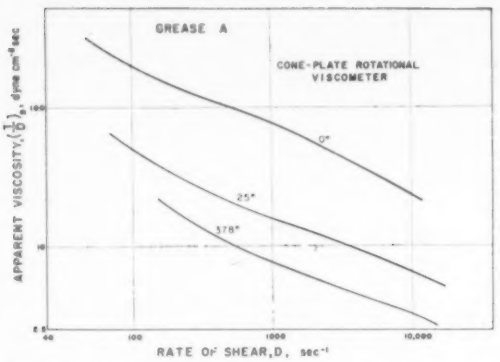


FIGURE 9, apparent viscosity, $\frac{\tau}{D}$, as a function of rate shear at 0°, 25°, and 37.8°C, from measurements on grease A in cone-plate viscometer, logarithmic scales.

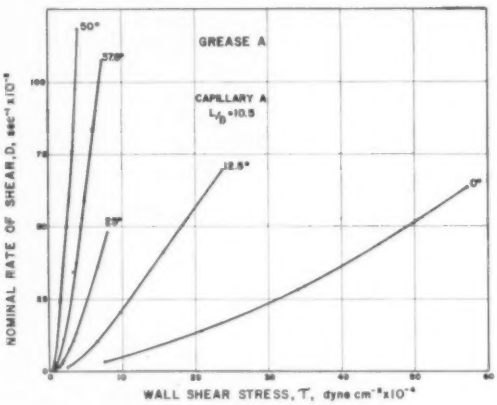


FIGURE 10, flow curves of grease A in capillary viscometer obtained at 0°, 12.5°, 25°, 37.8°, and 50°C with a tube of length to diameter ratio of 10.5.

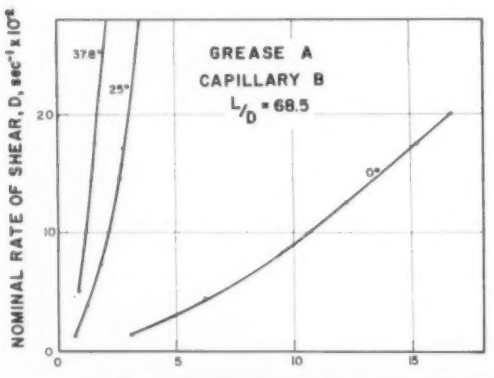


FIGURE 11, flow curves of grease A in capillary viscometer obtained at 0°, 25°, and 37.8°C with a tube of length to diameter ratio of 68.5.

rise of the sample under shear was not as great as the limit of detection, 0.1°C, as shown by thermocouples insulated from the base plate but in contact with the grease.

To provide information for comparison with rate of shear data obtained by means of the capillary viscome-

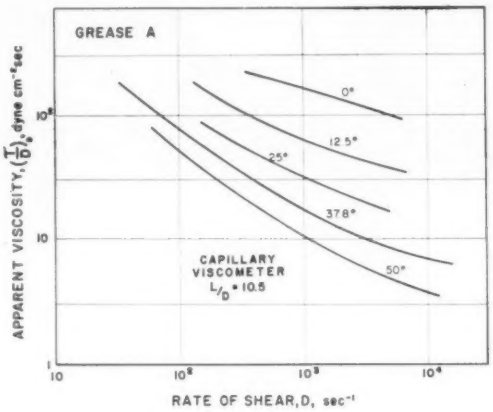


FIGURE 12, apparent viscosity, $\frac{\tau}{D}$, as a function of rate of shear at 0°, 12.5°, 25°, 37.8°, and 50°C, from measurements on grease A in capillary viscometer tube $\frac{L}{D}$ = 10.5, logarithmic scales.

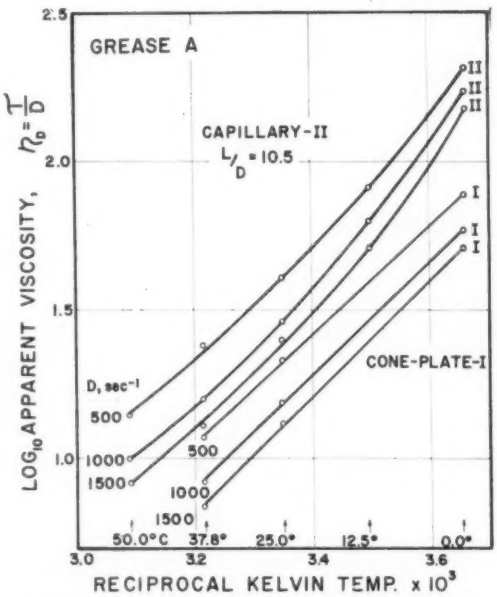


FIGURE 13, comparison of apparent viscosity as obtained for grease A from capillary tube viscometer and from cone-plate viscometer, as a function of temperature at selected rates of shear. Scales, $\log_{10} \frac{\tau}{D}$ and $\frac{1}{T}$.

ter, cycles of shear acceleration to approximately 1.5 x 10^4 sec^{-1}, followed by immediate deceleration, were carried out at 0°, 25° and 37.8°C for grease A. The maximum temperature rise in these experiments was 1.2°C at 25°, observed near the peak of the cycle. Apparent viscosities, $\eta = \frac{\tau}{D}$, were calculated from the flow curves. Values of $\log_{10}\eta$ were plotted versus $\log_{10}D$, in Figure 9.

Capillary viscometer flow information

Measurements of the flow rate developed at various pressures were made at 0°, 25°, and 37.8°C upon samples of greases B, C and D, in capillaries for which $\frac{L}{D'}$ was 10.5. Grease A was studied in greater detail, as to temperature, at 0°, 12.5°, 25°, 37.8° and 50°C, in the capillary for which $\frac{L}{D'}$ was 10.5. The results are shown in Figure 10 in flow curves in which the nominal rate of shear, D, is plotted versus τ, the shear stress at the wall. D and τ were calculated according to the following relations, from the driving pressure, P, the volume flow rate, Q, and the length, L, and radius R, of the capillary tube:

$$D_{nominal} = \frac{4Q}{\pi R^3}, \quad \tau_{wall} = \frac{PR}{2L}$$

Flow curves obtained for grease A in a capillary of $\frac{L}{D'} = 68.5$ are shown in Figure 11.

From the flow data for grease A in the capillary of $\frac{L}{D'} = 10.5$, apparent viscosities, $\eta_a = \frac{\tau}{D}$, were calculated. In Figure 12, $\log_{10}\eta$ is plotted versus log D at the various temperatures of measurement.

Comparison of variation of viscosity with temperature in the capillary and the cone-plate viscometer

Apparent viscosities, $\frac{\tau}{D}$, were calculated at three rates of shear, 500 sec^{-1}, 1000 sec^{-1}, and 1500 sec^{-1}, for grease A, and 500 sec^{-1} and 1000 sec^{-1} for greases B, C, and D, from the flow curves obtained in capillary measurements. Apparent viscosities were also calculated from the flow curves obtained in the second cycle of shear carried out in the cone-plate viscometer. For comparison, $\log\eta$ was plotted versus $\frac{1}{T}$, where T is the Kelvin temperature, in Figures 13, 14, 15 and 16.

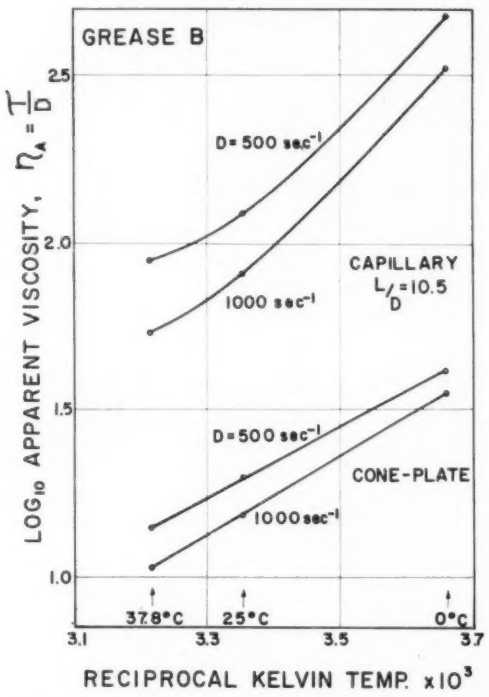


FIGURE 14, comparison of apparent viscosity as obtained for grease B from capillary tube viscometer and from cone-plate viscometer, as a function of temperature at selected rates of shear. Scales, $\log_{10}\frac{\tau}{D}$ and $\frac{1}{T}$.

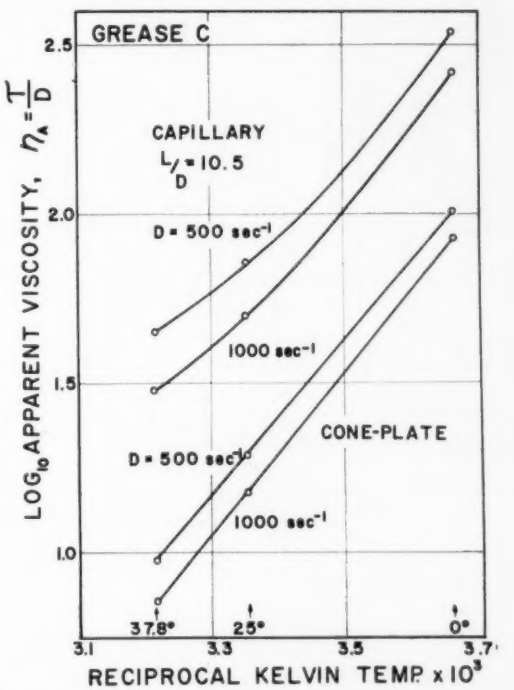


FIGURE 15, comparison of apparent viscosity as obtained for grease C from capillary tube viscometer and from cone-plate viscometer, as a function of temperature at selected rates of shear. Scales, $\log_{10}\frac{\tau}{D}$ and $\frac{1}{T}$.

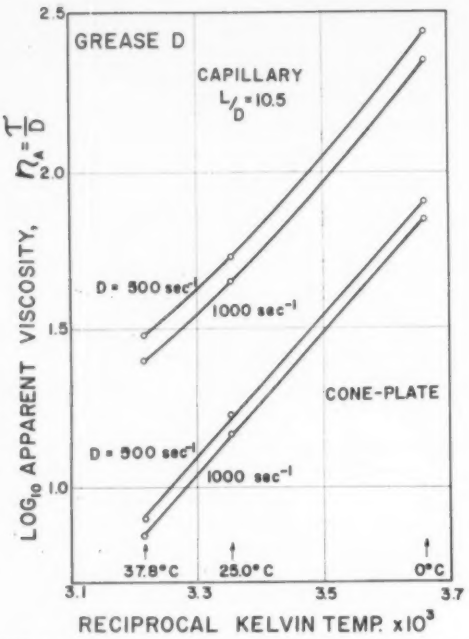


FIGURE 16, comparison of apparent viscosity as obtained for grease D from capillary tube viscometer and from cone-plate viscometer, as a function of temperature at selected rates of shear. Scales, $\log_{10} \frac{\tau}{D}$ and $\frac{1}{T}$.

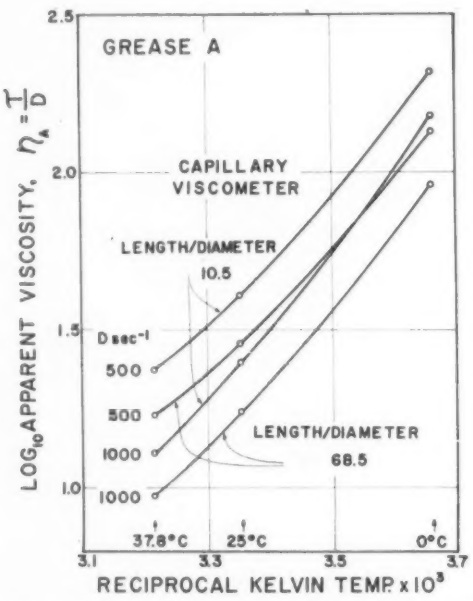


FIGURE 17, effect of length to diameter ratio of capillary tube on apparent viscosity of grease A at various temperatures. $\log_{10} \frac{\tau}{D}$ is plotted versus $\frac{1}{T}$ for results at 500 and 1000 sec^{-1} nominal rate of shear.

The effect on grease A of change of $\frac{L}{D'}$ on the relation of apparent viscosity to temperature is illustrated in Figure 17, for $\frac{L}{D'} = 10.5$ and for $\frac{L}{D'} = 68.5$.

Results for viscosities determined by means of the cone-plate viscometer for either the initially unworked or the worked greases, from cycles I and II, fitted a relationship of the form $\eta = A\, e^{\frac{(E_{vis})}{RT}}$ at any particular rate of shear, D, over the range of D in the test cycles. The values of E_{vis} increased slowly with increasing rate of shear. In Table I are listed values of E_{vis} at various rates of shear for the greases studied:

TABLE I

D, sec^{-1}	*Grease A* E_{vis}, *kcal*	*Grease B* E_{vis}, *kcal*	*Grease C* E_{vis}, *kcal*	*Grease D* E_{vis}, *kcal*
500	8.60	4.92	10.5	10.2
1000	8.97	5.38	11.1	10.4
1500	9.20	—	—	—

Discussion

For all the greases studied, the apparent viscosities at a specified nominal shear rate obtained from capillary viscometry were higher than those obtained from use of the cone-plate instrument. Also, the plots of $\log \eta$ versus $\frac{1}{T}$ were uniformly curved for apparent viscosities measured in the capillary viscometer. In the case of the cone-plate measurements, it was found that at all rates of shear, and in both the initial and the repeat cycle of shear, the relationship between apparent viscosity and temperature was given closely by

$$\eta = A\, e^{\frac{(E_{vis})}{RT}}$$

where (E_{vis}) is a function of rate of shear, D.

Since the same materials were subjected to shear in the two types of viscometers, the divergence in the results as to the effect of temperature must be ascribed to the fact that in the case of the cone and plate measurements, apparent viscosities were obtained from uniform rates of shear and uniform shearing stresses, while this was not the case for the capillary measurements. In the capillary tube, the shearing stress measured was the wall shearing stress, and the nominal rate of shear was an average value depending on the flow rate.

When sufficient flow data are available from capillaries of various $\frac{L}{D'}$ ratios, it is possible to correct for entrance effects by calculation of the shearing stress from a corrected length of capillary, L + L′, as previously described. Correction may also be made by de-

termination of limiting shear stresses obtained from plots of the shearing stress required to give specified shear rates versus the radius to length ratio of the capillaries used.[13] The real rate of shear may then be obtained from

$$D_{real} = \frac{D_{nominal}}{4}\left[3 + \frac{d \log D}{d \log \tau}\right]$$

In all such measurements made with capillaries of various $\frac{L}{D'}$ ratios, the data obtained at values of $\frac{L}{D'}$ higher than 10 are subject to serious errors because of temperature increases during flow in the tube.[7] It does not appear feasible, therefore, to obtain clear-cut separation of the effects of temperature, rate of shear, and time of shear on flow properties of greases from capillary measurements.

Yield values from Cone-Plate Viscometer

From the flow curves obtained in the automatically controlled shear rate cycles in the cone-plate viscometer, the effect of temperature and working may readily

About the Authors

W. H. Bauer *graduated from Oregon State college with a BS degree in chemical engineering in* 1929. *He received a PhD in physical chemistry from the University of Wisconsin. He was assistant instructor, University of Wisconsin* 1929-33; *research assistant* 1933-34; *instructor, Rensselaer Polytechnic Institute,* 1934-38; *assistant professor* 1938-42; *Captain, chemical warfare service, technical division research and development, U. S. Army; chief incendiary oil development section, pyrotechnic division; chief physical, analytical, and test divisions, Fred project rocket launching fuels,* 1942-45; *associate professor, Rensselaer Polytechnic Institute from* 1945-48; *he has been professor of physical chemistry and head of physical chemistry division* 1948-*date.*

S. E. Wiberley *received a BA degree from Williams college in* 1941, *a MS degree from the Renesselaer Polytechnic Institute in* 1948 *and a PhD in* 1950. *He was senior chemist, manufacturing research, Congoleum Nairn Inc.,* 1941-44; *analytical research chemist, assigned by U. S. Army to Manhattan project, Oak Ridge, Tenn.,* 1944-46; *analytical chemist, General Electric corp.,* 1946; *instructor in chemistry, Rensselaer Polytechnic Institute,* 1946-48; *research associate, atomic energy contract,* 1948-50; *assistant professor,* 1950; *visiting senior physicist, Brookhaven National laboratory,* 1952; *associate professor, Rensselaer Polytechnic Institute,* 1954; *professor of analytical chemistry,* 1957. *He is a member of ACS, Society of the Sigma Xi and Phi Lambda Upsilon.*

D. O. Shuster *is presently studying for a PhD in chemistry at Rensselaer Polytechnic Institute. He is investigating the capillary flow properties of soap-in-oil systems under the guidance of Dr. W. H. Bauer and Dr. S. E. Wiberley with the partial support of a grant from the Socony Mobil Oil Co., Inc., to the friction and lubrication program, research division, Rensselaer Polytechnic Institute. Mr. Shuster received a BS degree in education, with a major in chemistry, from the University of the State of New York college for Teachers, at Albany, New York, in* 1954.

A. P. Finkelstein *obtained his BS and MS degrees in chemistry from the University of the State of New York college for Teachers at Albany, N. Y., in* 1955. *For the last three years he has been working toward a PhD in physical chemistry at Rensselaer Polytechnic Institute under the supervision of Dr. W. H. Bauer and Dr. S. E. Wiberley on the flow properties of model greases. This work has been partially supported by grants from the Esso Education Foundation. At present Mr. Finkelstein is assistant professor of chemistry at the State college for Teachers at Albany, New York.*

be detected and separated. For the greases tested, the yield values varied markedly with temperature, but in no case was the proportional change of the yield value with temperature as large as the proportional change of viscosity. Typical results from measurement of yield values are shown in Table II.

TABLE II

Yield Values of Greases as Functions of Temperature and Working

Grease	*Yield Value, dyne cm^{-2} x 10^{-5}*		
	0.0°C	25.0°C	37.8°C
A I	14.9	5.4	4.6
A II	14.2	4.1	3.0
B I	42.9	20.7	15.6
B II	3.5	1.3	1.1
C I	20.9	9.9	6.0
C II	7.0	2.1	1.3
D I	69.8	21.7	11.0
D II	7.0	3.0	1.3

I. Initial yield value from curve I.

II. Yield value for grease worked in initial cycle to 1500 sec^{-1} from curve II.

The lower rate of change of yield value observed may be explained in view of current grease structure theories according to which oil is thought to be immobilized in a network of fibers. The breaking of fiber contacts, and the straining or rupture of fibers, and the loosening of oriented oil molecules at fiber surfaces all involve Van der Waals' forces, which have a comparatively low temperature coefficient.

When yield values are compared before and after substantial working of the greases it is shown that there are two components of structure involved. A portion of the initial yield value is lost after any considerable shear, and is not recovered in periods of twenty-four hours in the case of the greases tested. The yield value shown after shear was recovered and remained relatively constant in repeated cycles of shear on the same sample, the yield structure being reversibly established in brief periods of rest. It may be that the partial restoration of the yield value after working involves primarily establishment of oil-fiber surface immobilization. At the high viscosities at low rate of shear, disalignment of fibers oriented in shear would lead to re-formation of network structure through fiber contacts, so that the portion of the initial yield value arising from this source would be restored very slowly.

Conclusions

It appears very difficult, at the present time, to describe the flow properties of greases in tubes in terms of a few parameters derived from time, temperature, and rate of shear-shearing stress information gained from capillary tube viscometry. The practical value of data obtained from capillary viscometry, is, of course, very great, because it provides information concerning flow of grease in pipes, which is basically important in industrial practice.

The cone-plate viscometer with automatic programmed shear rate acceleration control and recording does enable rapid determination and clear separation of the grease properties, yield value, real shear stress-rate of shear relationship, shear stress-time relationship at constant shear rate, and effect of temperature. Because of this, the importance of study of grease flow in capillary tubes is increased rather than diminished. From more knowledge of values of pressure and flow rate in capillaries of known dimensions over a range of temperatures, such studies as those reviewed by Brunstrum and Leet[3] may enable correlation of grease flow in tubes with fundamental properties readily determined in cone-plate viscometry.

Acknowledgment

Acknowledgment is made of the assistance of David L. Hansen and Charles A. Larom in the initial phases of this work. This investigation was supported in part by grants from the Esso Education Foundation to the Chemistry department and from the Socony Mobil Oil company, Inc. to the friction and lubrication program, Research division, Rensselaer Polytechnic Institute.

Bibliography

1. *NLGI Spokesman* 19, No. 1, 9 (1955).
2. E. O. Forster, J. J. Kolfenbach, and H. H. Leland, *NLGI Spokesman* 20, No. 3, 16 (1956).
3. L. C. Brunstrum and R. H. Leet, *NLGI Spokesman* 20, No. 3, 24 (1956).
4. C. R. Singleterry and E. E. Stone, *J. Colloid Science* 6, 171 (1952).
5. ASTM standard method, D1092-51 (1951).
6. L. W. McLennan and G. H. Smith, *ASTM Bulletin* 152, 71 (1948).
7. M. D. Hersey and J. C. Zimmer, *J. App. Physics* 8, 359 (1937).
8. R. N. Weltmann, *NLGI Spokesman* 20, No. 3, 34 (1956).
9. R. McKennell, Proc. of the Second International Congress on Rheology, London, England (1953).
10. R. McKennell, *Anal. Chem.* 28, 1710 (1956).
11. M. Mooney and R. G. Ewart, *Physics* 5, 350 (1934).
12. N. Weber and W. H. Bauer, *J. Phys. Chem.* 62, 106 (1958).
13. W. H. Bauer, N. Weber, S. E. Wiberley, *J. Phys. Chem.*, 62, 1245 (1958)

Lubricating Grease in Industry—1

Recent Developments and Trends In Industrial Gear Lubricants

Presented at the NLGI 26th annual meeting in Chicago, October 1958

By: E. S. Reynolds
Socony Mobil Oil Co., Inc.

DEVELOPMENTS IN GEAR lubricants are very closely related to design trends and application practices in the gear industry.

Industrial gears, in general, have gone through some major changes in design which make the selection and application of lubricants much more critical than in the past. Increase in pressure angle has increased permissible hp loading and increased pressure on the lubricating film. Modifications from the standard full-depth tooth have also, in some cases, increased sliding velocity, which means higher shear rate for the films formed between mating gear-tooth profiles.

To fully appreciate the requirements that affect lubricant selection, it is extremely important that we continually review the relative movement of gear-tooth profiles as they go through mesh. This applies in particular to gears of spur, helical, herringbone, straight-bevel and spiral-bevel type.

We will use a movable model of meshing gear sectors, similar to Figure 1, for this purpose. The gear teeth are designed with a 20° pressure angle and are full-depth involute teeth. By moving the model in the direction indicated by the arrow on the driving pinion, you will note that high sliding velocity is experienced when the teeth first make contact. This sliding velocity gradually decreases until contact reaches the pitch point. At this point sliding becomes zero, immediately changes direction, and then begins to accelerate in the opposite direction until disengagement. At the same time, rolling also takes place and is fairly constant throughout mesh and in the same relative direction during contact.

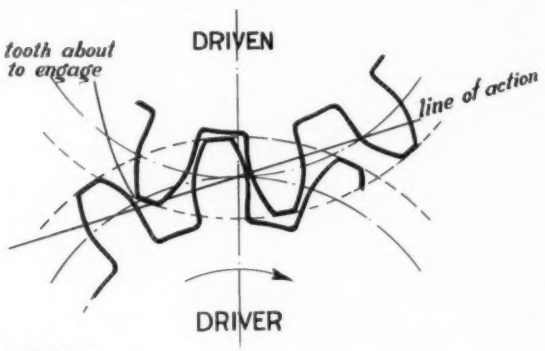


FIGURE 1

It is also interesting to note where succeeding teeth start and end contact. First contact is between the tip of the driven tooth and the root of the driver, where radius of tooth curvature is short and unit compressive stress is high. Sliding velocity is high here too. However, at this time at least two pair of teeth are carrying load. A little later, only one pair of teeth is carrying load, and where the driving tooth first picks up full load, a severe condition of loading is experienced. Toward the end of mesh, load is again carried by more than one pair of teeth.

Of course, with helical gears, more teeth are in mesh than with spur gears, and full load is never carried by one pair of teeth.

You will find it very helpful to file a mental picture of these meshing gears and the arrows which indicate direction of slide. Note that slide is always away from the pitch line on the pinion or driving tooth and is always toward the pitch line on the driven tooth. This accounts for the fact that the pitch line is usually visible and that there may even be a depression at the pitch line on the pinion with a corresponding ridge at the pitch line on the mating gear.

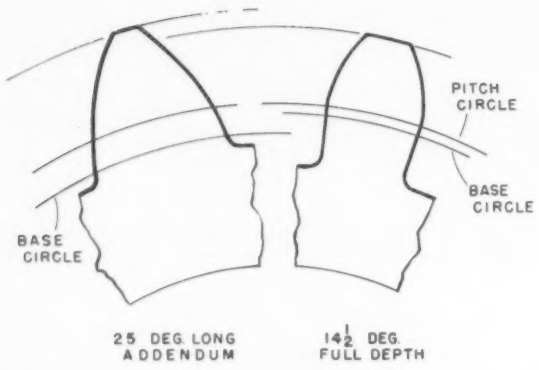


FIGURE 2

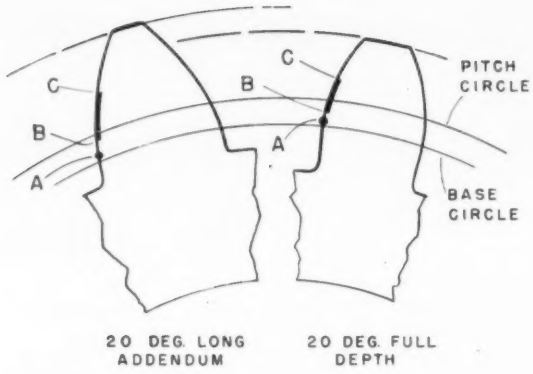


FIGURE 3

To further show what happens to a gear-tooth profile when the pressure angle is increased, Figure 2 illustrates an extreme in going from a 14½° pressure angle to a 25° pressure angle. It is obvious that the mechanical strength of the tooth is greatly increased.

Another method of improving mechanical strength of a gear tooth is to modify the design of the pinion by increasing the length of the addendum and decreasing the length of the dedendum. This would, of course, mean increasing the dedendum and decreasing the addendum correspondingly on the mating gear. With this modification, however, we are faced with higher sliding velocities when contact is toward the tip of the driving pinion. This modification also changes the point on the profile where contact begins and the area on the surface where maximum load and maximum surface stresses are encountered.

With the increase in mechanical strength of gear teeth, we must also bear in mind that the additional loading permitted is usually at the expense of gear life to some degree. The increased loading on the gear tooth surfaces can result in a different type of fatigue-failure pattern when compared with gears of previous design. With these increases in loading, the lubricant is a much more critical factor in the performance and life expectancy of a pair of gears, although the lubricant itself has only limited effect on metal fatigue. All of this leads to a lubrication requirement which in many cases can be met with improved additives that impart greater anti-wear, or extreme-pressure, characteristics. The better understanding of additive behavior in various combinations makes it possible to create better lubricants to perform a specific function. The ability to control the stability of the lubricant, extreme-pressure additive activity, demulsibility characteristics, and other desirable qualities for various applications make it possible to intelligently and satisfactorily lubricate the modern gear.

Also we know that pressure and temperature have a very important effect on viscosity, and while we have standardized on methods for obtaining temperature-viscosity relationships, we are gradually requiring more and more information on pressure-viscosity relationships and a uniform method for obtaining these relationships. The latter is being studied by ASTM and other groups and we hope will become a greater part of the know-how in lubricant selection in the near future.

In conclusion, we might say that recent developments in industrial gear lubricants have resulted from a better understanding of materials available and how they act and react. We must also give considerable credit to studies in the application of lubricants since the best lubricant in the world can be a complete failure if it does not get to the surface which requires lubrication. We feel entirely confident that the development and application of better gear lubricants will keep fully abreast of the new developments in gear design.

About the Author

E. S. Reynolds *attended Syracuse university and is a graduate mechanical engineer. He is a licensed professional engineer in New York and Pennsylvania. At Socony Mobil Co., Inc., with whom he has been employed 25 years, he is a senior engineering representative, industrial div., lubricating department, headquarters staff. A specialist on gears, gear lubrication and gear failures, he has delivered numerous lectures on various gear subjects, including "Basic Causes of Gear Failures" before a number of technical societies, at several universities and for the Royal Canadian Navy. Mr. Reynolds is an active member of ASME, AISE and ASLE and National technical committees.*

Facts and Factors In Grease Manufacturing Costs

Presented at the NLGI 26th annual meeting in Chicago, October 1958

By: M. S. Mingledorff
International Lubricant Corp.

Introduction

The particular subject now on the agenda, namely "Facts and Factors in Grease Manufacturing Costs" is neither deeply absorbing, intensely interesting, nor highly technical. It might be said that accounting topics can put people to sleep almost as effectively as modern tranquilizer pills and are not nearly so expensive. As a general rule accounting text books seem to lack that personal touch which is found in such literary gems as "Tom Swift and His Giant Airship" and "The Bobsey Twins in the Country."

There are, of course, some reasons why this audience should *not* be interested in grease manufacturing costs. Those are easy enough to list. But let's consider why you *should* know something about them.

In the first place, when some period of poor sales and consequent low profits is ushered in (this is more familiarly referred to as a recession or a depression) most business men look around for and begin cutting costs. But before you cut them, you've got to recognize them for what they are and you have to know where to find them. The natural habitat of manufacturing costs is a place commonly known as a factory. Here they may exist in large or small numbers depending upon their environment and whether they are controlled or not controlled. The object of this paper, or our mission today, is merely to introduce you to these characters. After you have been properly introduced, you might then give some thought to the methods of controlling them. It has been proven in the past that if we can control costs we can sometimes save money . . . and you might as well save it; they say it might be valuable *again* some day.

One of the prime reasons why you should be interested in manufacturing costs is that production efficiency is often measured in terms of such costs. Naturally we strive for efficiency and for lower costs in order to gain an advantage over our competition. But within the past year or so there has come to the attention of the American business man and the American public a more cogent and pressing reason for greater efficiency. The industrial and economic strength of the United States has been challenged by the Soviet Union in a fight to the finish. The Russian economy has been growing and is expected to *continue* to grow through 1962 at a rate twice that of the United States. And we should not deceive ourselves that the base upon which the Soviet rate is calculated is so small that they won't catch up. Because it isn't small and they *can* catch up! It takes ten months for our cumbersome, democratic political machinery to accomplish what sometimes can be done in ten days by a totalitarian state. Whether we like it or not, we are engaged in a race in which the stakes are extremely high—perhaps as great as national survival. For this one reason alone we should seriously consider the accounting signposts along the road to greater efficiency and productivity.

To define the scope of today's discussion we might say that Manufacturing Costs begin at that point where we purchase our raw materials and introduce them into the processing system. They usually end when we put the finished goods into a truck or some other transportation vehicle destined for delivery to the finest people in the world—our customers.

A glance at Chart I will give you a graphic picture of how these Manufacturing Costs fit into the over-all costs of doing business or operating a grease plant. We are concerned here, of course, with only the left hand part of the chart.

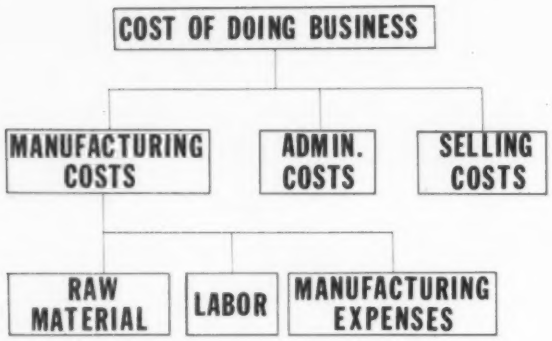


CHART 1

Let us, for a moment, consider the difference between the two terms "Manufacturing Costs" and "Manufacturing Expenses." Costs is the more all-embracing term, as it includes the 3 broad categories which everyone readily recognizes, namely;

1. Raw Materials
3. Labor
3. Manufacturing Expenses

Manufacturing Expenses, as referred to here, includes all those expenses related to the operation of a factory except Labor, which is set out as a separate item. We shall learn more of these Manufacturing Expenses in detail later.

As we proceed you will undoubtedly note that a great deal of this exposition is pitched at a rather elementary level. Believe me, this is no reflection upon the intellectual capacity of this audience; it is merely a device adopted to avoid putting you into that mesmeric trance that is usually brought on by reference to such topics as joint costs, standard costs, fixed and variable costs and other Sandman subjects that serve to bring on that tired, listless feeling.

Cost of Raw Materials

Of the three broad categories, Materials, Labor and Manufacturing Expenses, the first, namely Materials, represents the greatest part of the total cost of a pound of grease. In order to more easily grasp the relative values of the items or components that go into a grease price, a *vastly* simplified version of the calculation of a grease costing 9 cents a pound exclusive of container, is shown in Chart II. To this cost of 9 cents we add a profit, of course, in order to arrive at the selling price.

However, we know that the selling price is not determined in this way alone. Competition plays a tremendously important part in the picture. Then, too, costs differ at various plants because of their location. Some are at a disadvantage in producing certain kinds of greases because they are further away from the source of raw materials and their freight costs are consequently higher. Again, labor costs vary in different sections of the country.

The cost of the raw materials that goes into a grease is one of the prime reasons why the price has increased so much in the past ten or fifteen years. Not only have the costs of oils and soaps gone up but today we are using more expensive and higher quality oils and, in addition, many more different kinds of raw material than we ever did before. Grease has graduated from the kitchen to the laboratory and may now be termed a combination of homogeneous ingredients resulting in an oleaginous substance designed to facilitate the reduction of inharmonious movement between two materials.

In keeping with the trend of the times and with the demands made by progress it is necessary to produce today a much superior and more complex product. Two decades ago, when simple formula cup and gear greases were being made, the cost of raw material (oil, hog fat, lime and so on) amounted to about 2 cents per pound or about 40 per cent of a grease that sold for five cents. Today, in a popular grease that is no longer low in cost or price, the raw material would probably run 50 or 60 per cent of the total cost. It might be pointed out, however, that the customer is still getting a good bargain—the high costs and high prices are relative only to what they used to be. The margin of profit that goes to the manufacturer has not been nor probably ever will be more than just and reasonable.

To produce a pound of grease in these days and times, we need not only many more kinds of raw materials, but much greater technical knowledge and more complex equipment as well as lengthy processes and extensive tests. While increases in production volume have held unit costs (and consequently prices) down, this factor has been more than offset by the cost and diversity of raw materials. Costs other than materials have risen, very true, but no single element has risen so much in absolute amount, that is in terms of cents per pound, because, per se, raw material is the largest single cost component.

GREASE COST CALCULATION (SIMPLIFIED)

RAW MATERIALS	$.050 PER LB.	
LABOR	.009	
MFG. EXPENSES	.011	
TOTAL MFG. COST		$.070
ADMIN. COST		.007
SELLING COST		.013
TOTAL ALL COSTS		.090

CHART 2

However, lest we fall into the error of oversimplification in this matter of increased costs, we might also mention the effects of inflation or devaluation of the dollar as well as the tremendous amounts spent on research and development and the increasingly complex methods of manufacture. We might say, in summary of this aspect of the situation, that progress has its price.

To the cost of any raw material we must add the freight-in expense—we know that articles such as phenylalphanapthylamine don't grow in the back yard. This cost of transportation is no inconsiderable item; it sometimes determines where new plants will be built and what old ones should be scrapped.

Then, in raw materials, there is the question as to how much money should be tied up in inventories. How much is enough to keep on hand? "A cupful and a half," says the treasurer. "Two million gallons," says the production superintendent. "20 different chemicals are sufficient," says the treasurer. "150 is the absolute minimum," says the superintendent. The higher the inventory, the greater is the cost of the money you have tied up in it. These are just some of the cost problems you run into when considering the cost of raw materials.

Something which may be worth mentioning here, although it is not exactly a cost but more properly termed a loss, is inventory devaluation. We have witnessed examples of this during the recent recession. When the price of oils drop and a grease manufacturer has a large quantity on hand he may suffer a loss because his customers demand a reduction in grease prices immediately, based on the newly published oil quotations. Of course, the same grease manufacturer stands to gain on a rising market, but the competitive situation is usually so keen, that such gains are held down to a minimum.

A great many accountants, it might be mentioned here, refer to raw materials as a "non-controllable" cost. Actually, you can affect the cost of many articles by looking around and finding a substitute which costs less, goes further or performs better. Perhaps here, lies our most fertile field for lowering costs because here is where most of the manufacturer's money is spent.

Labor

Labor, as most of us know, is divided into two broad categories, Direct and Indirect. Anything directly concerned with production is in the former classification while such characters as warehousemen, loaders, checkers, maintenance men, boilermen, watchmen and janitorial and clean-up men are indirect on non-productive workers. We also have some workers who are so indirect in their efforts that it is difficult to detect them except on pay day. They are sometimes referred to as "overhead" or "non-operating staff personnel." A pertinent example of this overhead that sometimes gets underfoot is Treasurers who run around the country making short talks at long meetings.

Indirect labor is seldom set out as such on the books. It might be found under headings like Maintenance Expenses and Supplies, Warehouse Expense or some nomenclature under which it is not easily recognizable.

Any expense connected with labor, be it direct or otherwise, is almost bound to be sensitive and sometimes downright explosive in nature. The handling of manpower is a most important thing. Whenever you touch a man's pocketbook, you touch a most vital area. It has been said that women are explosive also. If you don't believe this, just try dropping one.

In a period of general business depression, the solution to the maintenance of profitable operating levels may not always lie in drastic cuts in labor forces but rather in a reduction of hours worked along with a psuedo job guarantee to create confidence and keep up the purchasing power of consumers.

Many accountants will say that direct labor expense will fluctuate in proportion to the volume of production. As a matter of fact this is not always necessarily or literally true unless the workers are paid strictly on a piece work basis. The workers just don't put out as much effort when business slacks off. In other words, he is inclined to stretch out the job if he thinks he can get away with it. And he frequently does. You and I would, too.

What happens in a great many instances is that management desires to retain its worker group intact. This it does for a number of reasons. Management feels that it owes something to the community and to its employees to keep them on the payroll. Perhaps in the long run it will be to everyone's advantage to retain skilled and semi-skilled employees even though the going may be temporarily rough on the Profit and Loss Statement.

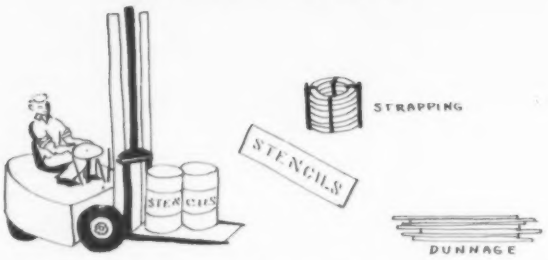
Closely allied to labor expense is its almost inseparable companion: the so-called fringe benefits deal. It is especially true in the oil industry that fringe benefits cost quite a bit; sometimes they amount to as much as 20 percent or more of an employee's salary or wage. In this category we class such items as pensions, group life insurance, survivor benefits, group hospitalization plans, paid vacations, company picnics, service dinners, awards and many other expenditures that Management makes in order to keep the worker satisfied and happy.

Having discussed raw materials and having circumvented some of our labor problems we now come to:

Manufacturing Expenses

The bookkeeping accounts that fall into this classification are named in order that we may be able to identify costs of the same nature, recognize them and

SHIPPING EXPENSES



control them. There are lots of fish in this barrel and we can shoot plenty of them without half trying. The best way to cover the field and get acquainted with the account names that show up on the financial statement (that is, the profit and loss or operating statement) is to mention a few examples of expenses of a manufacturing plant.

Shipping Expenses

In most plants this is a rather sizeable item. Here we can find a good deal of that indirect labor expense we previously discussed. Salaries and wages of workmen and foremen who move merchandise from the production line and put it into box cars and other vehicles can amount to substantial sums. This is closely tied in to plant layout, schedules, equipment and methods, all of which subjects are too lengthy and involved to discuss here.

Ordinarily we find classified as shipping expenses items such as stencil supplies, ink, rubber stamps, gaskets, seals and other things necessary to put the containers in shipping shape. Particularly in box car loading we will be concerned with dunnage and strapping. However, modern methods of loading and bracing plus smart plant superintendents have done a great deal to reduce this expense as well as to cut down on railway damage claims. If a plant is located at a port city and ships export, there may be drayage expenses to the docks, switching, unloading and tollage charges to be paid.

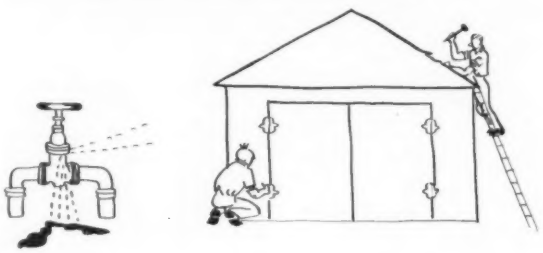
WAREHOUSE EXPENSES

Warehouse Expense

Closely allied to shipping expense is the cost of warehousing. This is one of those insidious expenses where you never seem to get your money's worth. Sometimes there seems to be no sense in the dollars spent for moving goods from production line to warehouse and from warehouse to trucks. Like the old timer and now almost forgotten cavalry soldier who claimed to be a pilot; it's a case of pile it here and pile it there. Put a floor on the ground, a roof overhead, add a little depreciation, and a dash of taxes; shake well with labor and maintenance and you'll come up with a fair sized warehousing expense that may result in a real headache.

Yet, upon analysis it may be found that a great deal of this storage cost is an absolute necessity. Warehousing is a must if a plant is to cook in batches larger than two or three drums; it is likewise a must if you want to give your customer prompt service and a clean, attractive package.

MAINTENANCE EXPENSES



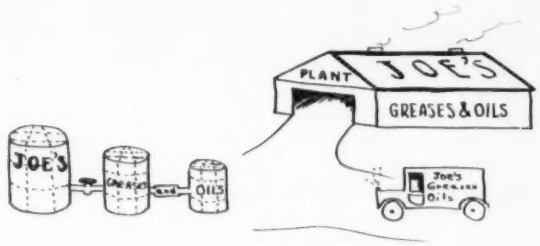
Maintenance Expense

It is often remarked about marriage, that it isn't the initial expense that's important; it's the upkeep. And sometimes, so it seems with a grease plant and its maintenance problem.

We might say that there are two kinds: preventive maintenance and necessary maintenance. The first kind usually costs a lot of money; everything is kept in tip top shape, housekeeping is excellent; old paint never has a chance to scale off and emergency jobs are not frequent. Everything is first class—even the repair bills come in regularly and on time.

Sometimes maintenance charges are apt to run high during an active period of building and construction. This occurs because some jobs are too small to set up as assets and must be charged off to current expenses. In this field of maintenance we find one of those phases of accounting, a sort of twilight zone, which is sometimes given too much argument. The question here is "Shall we capitalize it or shall we charge it to maintenance?" Most of the time there is no clear cut answer and conservative management will decide that the maintenance account will have to bear the brunt

DEPRECIATION



of the charge, if, of course, there is some basis for justification.

Depreciation

Depreciation is a topic about which many books have been written, published, and actually read. There are many ways to compute depreciation but the one most commonly used is called the straight line method. When reduced to its simplest terms, this is merely translating the estimated life of the asset into a percentage, that is, a 20 year life is written off five per cent each year and so on. Some of the other kinds of depreciation are: the declining balance method, the annuity method, the sinking fund method; and various plans based on the output or service of the asset being depreciated.

Depreciable assets are any assets which will wear out, of course. Thus we have buildings of all sorts, steel, concrete, brick, wood and so forth; tanks, large and small, piping and valves galore, and all kinds of machinery and equipment too numerous to mention. There can be many different rates of depreciation too. They might start at two per cent for a 50 year asset and work up to ten per cent and even beyond; although it is not too common to capitalize items of a short life, particularly if the amount involved is small.

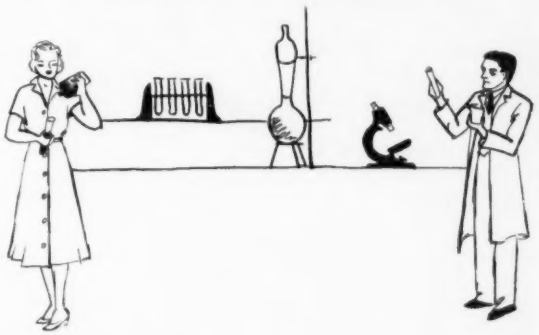
Sometimes the rate of depreciation approved by the Federal Government for income tax purposes is too low to satisfy a conservative management. In this case, one rate can be used for income tax purposes and another, or higher rate is used for internal accounting purposes.

A depreciation charge can be a dangerous thing if it continues to grow while revenue remains constant or even begins to slide off. Due to the fact that this is a fixed charge, heavy investments in long term assets should be viewed with caution. It is possible for a firm to change a loss into a profit by merely manipulating downward its depreciation rates, of course. However, this is rarely done, as it is likely to give the perpetrator sleepless nights, many headaches and much confusion, not to mention the fact that he may run afoul of Federal laws if the standard rates of the Treasury Department are not observed.

This leads to the comment that in the eyes of the accountants and statisticians, constancy is truly a shining virtue; in the eyes of the Revenue Department any deviation from constancy is viewed with grave suspicion and is likely to invite investigation.

Closely related to depreciation is a cost factor known as obsolescence. Technically obsolescence can cause a piece of machinery to become useless faster than it can be depreciated by the wearing out process. If your competitor can lower his costs appreciably by installing new equipment it may be economic suicide to hang onto your old machinery. However, up to this time obsolescence has not proven to be an important factor in grease making because no revolutionary developments have occurred in the manufacturing processes that would cause old equipment to be scrapped overnight.

LABORATORY EXPENSES



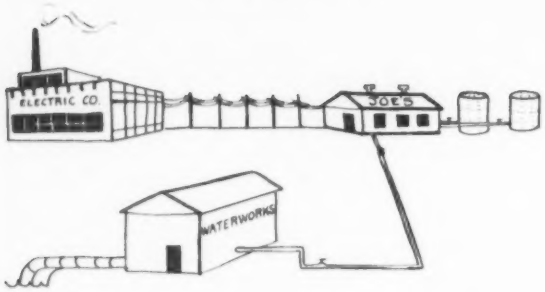
Laboratory Expense

When we mention laboratory expense, perhaps we should point out that there is a good deal of difference between a lab for the checking and control of specifications on your products and a lab which is engaged in research and development work. Expenses of the former, or control lab are apt to be within reason and somewhat in line with the quantity of goods produced, but the latter can be an open end proposition with the sky as the limit. In other words, a research laboratory can run into plenty of money—but who can afford to be without one?

We look to the lab today as a source of new products as well as a place to improve the old ones. In the everlasting and continuous battle of competition, the laboratory is the marketing department's best friend. Close liaison between these two will add up to greater net profits at the bottom of the profit and loss statement.

The largest single item, normally, in operating any lab, whether it is a control or research group, is the money that is paid out in salaries and wages, of course. Supplies and equipment in maintaining this installation are minor in comparison with the expenditures for personnel on the payroll.

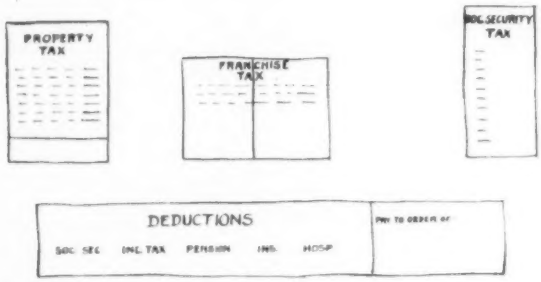
UTILITIES



Utilities

We find, among our utilities expenses, the usual electric bills, gas bills, water bills, sometimes telephone and telegraph but not often, and one not so familiar—namely sewerage bills. The size of the latter is not necessarily an indication of how dirty you are; there may be other factors involved. In some instances steam is purchased; in which case it could also be classed as a utility expense.

TAXES



Taxes

Taxes will be with us always. As the saying goes: there are two things you can always be certain of; death and taxes. The most common variety of taxes in a manufacturing establishment are property taxes, franchise taxes and social security taxes. Normally, income taxes are shown as the last item on the profit and loss statement after the profit from operations has been determined. Besides, you might be lucky and not have to pay any income taxes—if you don't have any net income. Sales taxes are usually not set out as such but are merely added to the cost of whatever is purchased and the total is treated as the cost of the article.

There are some ways of avoiding or reducing some taxes if you have a smart tax man who is well acquainted with the provisions of the law. In general, though, there is not much you can do about them. No matter where they appear, taxes are always unpopular items. And lest we get too deep in the heart of taxes, let's move on to another commonly recognized item of manufacturing expense; that is

PLANT SUPPLIES

Supplies

From the standpoint of the number of items involved, the term supplies as a manufacturing expense can cover a lot of territory. However, in terms of money, the amounts are apt to be rather modest. For instance, a quart of gasoline for a blow torch necessary to repair a leaky drum may be a plant supply item. And so would be the paint with which to touch up a rusty reconditioned asphalt drum to convert it into a brand new 400 pound 18 gauge grease drum for some unsuspecting customer. Then we have other supplies such as wiping rags, decals, vitamin or salt pills, glue and even perhaps oil and grease to lubricate the drive shafts on our mixing kettles. But, all in all, the total dollar expenditure will probably remain small in amount.

INSURANCE

Insurance

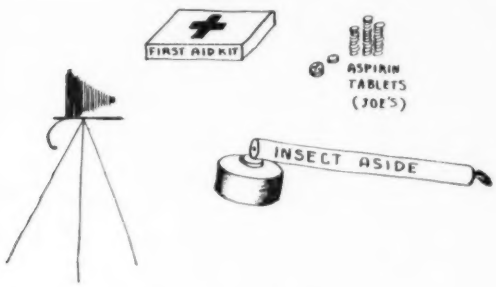
There are many different kinds of insurance and most certainly there will be a charge for each one. Fire and extended coverage usually heads the list and this kind of protection is a "must." As anyone who has experienced a fire loss can testify, they are definitely *not* profitable. The best procedure that can be adopted immediately after a fire is to thoroughly inventory everything that was affected by it; make and keep de-

tailed and meticulous records of the damage and be sure to include plenty of photographs. It is realized, of course, that a fire loss can sometimes be used by the unscrupulous as a short cut to modernizing plant and equipment.

As to other types of insurance, we have liability, both general and automobile, (and there are other types, too). Then there is workmen's compensation insurance which can sometimes be a very important item. This expense, a manufacturer can control to some extent by a well directed, enforced, safety program.

Use and occupancy insurance is probably not too widely written as many firms feel that they can tighten their belts and get by in the event of an emergency.

MISCELLANEOUS MANUFACTURING EXPENSES



Miscellaneous Manufacturing Expenses

Miscellaneous manufacturing expenses are, as the name implies, too small and unimportant to set out as separate expenses. Here you may find such things as supper money for overtime workers, on-the-spot Polaroid photographs showing freight car loadings, the cost of advertising to sell a second-hand boiler, bandages for injured workmen and aspirin for the plant superintendent. You might even find here a bill for insect and pest control if you have ants in your plants.

There is little worthy of an extended discussion here. The best that can be accomplished in an examination of this account is to see that it does not become a dumping ground or a hiding place. When it does become this, however, the size of the account, or its total will readily indicate that an analysis of the detail should be conducted.

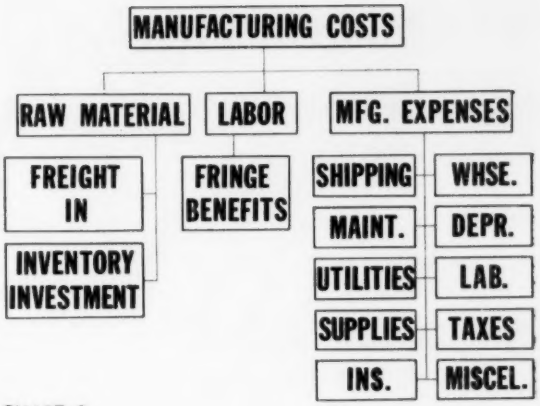


CHART 3

Summary and Conclusion

And now in summary and conclusion, we may say that we have struck up an acquaintance with some of the facts and factors in grease manufacturing costs. We now recognize and know, if we had not indeed already done so, the elite and well known members of this society.

As a means of recapping most of the subjects that have been discussed Chart III has been compiled. This is shown merely to give you a brief picture of the topics we have been over, around or through.

It should be borne in mind that the use of figures as an instrument of control is still a primary tool of management. As a matter of fact, figure control is practiced not only by industrial plant managers but by many household managers as well; to the evident satisfaction of all concerned.

But even though digits and dollars are the lifeblood of business and commerce, it should be remembered that the analysis of figures is not decision, comprehension is not achievement and dreaming is not doing. Some of the finest reports ever written, accounting and otherwise, are rotting away in filing cabinets this very moment because of the lack of decisive action to implement them.

Solely and alone, in the head, in the hearts, and in the hands of management's leaders lie the responsibilities and the opportunities for action to transpose figures into deeds. ■

About the Author

M. S. Mingledorff *was graduated from Tulane university in* 1927 *with the degree of bachelor in business administration. After further study he then graduated from the Harvard business school in* 1933 *with a masters degree. Mr. Mingledorff at this time holds the position of treasurer of the International Lubricant corporation and is a recognized authority in determining cost factors in the manufacture of lubricants.*

Literature and Patent Abstracts

Manufacturing Methods

Manufacture of Soap

Soaps applicable to the manufacture of lubricating greases are formed at room temperature according to Lamson and Renshaw (U. S. Patent 2,860,151). The procedure consists of dissolving the fatty acids in a hydrocarbon solvent after which a dry oxide or hydroxide or the latter in a water solution is used to neutralize the acid. Such solvents can be removed before or after mixing with lubricating oil at room temperature and in either case lubricating greases result. The illustrations given contain 20 to 30 per cent of soap in most cases.

A number of modifications and other solvents may be used in forming such soaps. In one case the particle size of solid lithium hydroxide was reduced by dissolving it in water and causing it to precipitate out of solution by adding acetone. After drying thus lithium hydroxide was reacted with stearic acid dissolved in benzene. A good lubricating grease was said to be formed by combining an oil with either 20 per cent of the dry soap or the soap in a slurry form.

In another case a solution of stearic acid in methyl alcohol was reacted with dry sodium hydroxide. The resulting solution of sodium stearate was stirred into a quantity of petroleum ether to form a slurry of soap which was filtered to leave a dry soap. Here again 20 per cent of this dry sodium stearate mixed with oil at room temperature was stated to give a satisfactory lubricating grease.

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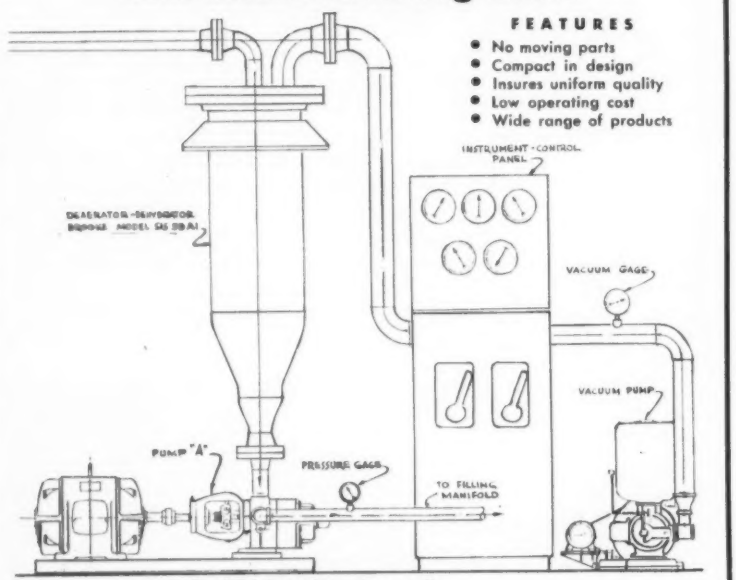

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Equipment

Flow Sheet for Manufacture of Lubricating Grease

Petroleum Refiner 37, p. 313, September 1958 has a flow sheet for lubricating grease manufacture by Stratford Engineering corporation. A description of the process states that a typical time cycle for the manufacture of calcium base grease is one and a half to two hours, and for soda base grease, two to three hours.

Gear Lubricants

Stabilized Extreme Pressure Gear Lubricants

Gear compounds, containing both fatty acid ester compounds and phosphorus as well as sulphur, are inhibited against polymerization by the addition of about 0.1 per cent of nitrogen-containing, fatty acid-derived, aliphatic hydroxy compounds, such as amines, amids and amine salts. Chapman and Manteuffel (U.S. Patent 2,820,-013, assigned to The Pure Oil Co.) illustrate such a lubricant containing the following per cents by weight: 13.0 of E. P. base consisting of sulfurized methyl esters of tall oil fatty acids and phosphorized glycerol trioleate; 1.0 of dibenzyl disulfide; 1.0 of Acryloid 150; 54.0 of 150 viscosity SUS at 210°F. bright stock; 30.9 of 170 viscosity SUS at 100°F. neutral oil; and 0.1 of Duomeen T mono-ricinoleate.

Improved storage stability coupled with good performance characteristics of an E.P. gear lubricant are claimed by these authors in 2,830,024. The suggested lubricant

consists of an oil containing about 13 per cent of an additive made up of three to five parts by weight of sulfurized methyl esters of tall oil, one part by weight of a product obtained by reacting glycerol trioleate with phosphorus sesquisulfide, and 0.1 to 0.5 parts by weight of chlorinated naphthalene containing 10 to 40 per cent by weight chlorine.

Hypoid Gear Lubricants

According to Sands, Davis and Cunningham (U.S. Patent 2,850,-452, assigned to Monsanto Chemical Co.) E.P. lubricants effective for gears of vehicles operating under both high speeds and heavy loads consist of 85 to 96 per cent of a suitable oil, preferably an SAE 90 grade, and a combination of two additives.

Additive A is a chlorinated aliphatic material in which the more reactive part of the chlorine has been replaced with a thiocarbonate group. For example a chlorinated naphtha was reacted with a xanthate to give a dark brown liquid containing 11 per cent sulphur and 34 per cent chlorine.

Additive B is an oil soluble polyvalent metal salt of a thiophosphoric acid having two hydrocarbon substituents. Such a product was made by reacting thiophosphoric acid with zinc oxide to give a product having one part of phosphorus and two and two tenths parts of sulfur per part of zinc.

Either additive A or B alone, when mixed with a Mid-Continent SAE 90 grade oil, failed on gear tests. However, the same oil containing mixtures of either 8 per cent A with 1.25, 2.13 or 1.78 per cent B or 5 per cent of both A and B passed the L-19-645, L-20-545 or VV-L-761 tests.

Composition

Lubricants Containing Soap-Salt Complexes

Either fluid compositions, some of which are useful as gear oils, or lubricating greases are formed by dispersing certain calcium base soap-salt complexed in lubricating fluids according to Morway (U.S.

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Patent 2,856,362, assigned to Esso research and engineering Co.).

While various mol. ratios of the ingredients may be used, two examples, which will be tabulated, indicate the possibilities:

	Example I *Per ct. Wt.*	*Example II* *Per ct. Wt.*
Glacial acetic acid	12.0	8.0
Stearic acid	3.0	-
Calcium xylene sulfonate	3.4	-
Hydrofol acids 51	-	2.0
Hydrogenated castor oil	-	2.0
Hydrated lime	8.7	6.0
Phenyl alpha-naphthylamine	0.5	0.5
Mineral oil 55 SUS at 210°F	72.4	-
Diol 55	-	81.5

In processing the acetic acid was added after the fatty materials and lime had been mixed with the lubricating fluid at 150°F. The temperature was then raised to 500°F., the mixture cooled to 250°F. where the oxidation inhibitor was added. After further cooling to 180°F., the mass was passed through a Gaulin homogenizer.

Example I was a smooth fluid which carried a load of 60 pounds on a Timken test. When equal weights of the above products were mixed and passed through the homogenizer a smooth lubricating grease resulted which had a worked penetration of 325 and a dropping point of 500+. This passed a 40 pound Timken load and lubricated a bearing, operating at 10,000 rpm and 250°F, for 1500+ hours.

Extreme Pressure Lubricating Grease

Worth, (U.S. Patent 2,858,273, assigned to Union Oil company of California) while attempting to improve the extreme pressure qualities of lubricating greases containing the calcium soap of 12-hydroxy stearic acid as the thickener, found that addition of E.P. additives decreased the mechanical stability of the product. Further, it was found that by the addition of 0.2 to 1.2 per cent of glycerol or pentaerythritol to compositions such as the above the proportion of E.P. agents required was reduced. However, the resulting lubricating greases still had poor shear stability.

If in addition to the above compounds there is also added 0.2 to 2.0 per cent of triethanolamine or a soap of triethanolamine, such as the soap of 12-hydroxy stearic acid, the mechanical stability is maintained or improved.

Thus, a lubricating grease containing 7.5 per cent of calcium 12-hydroxy stearate softened 50 points on a beater test at 250°F. for three hours and failed at a load of 13 pounds on a Timken test. By adding 7.5 per cent of "Elco SCL" to the above lubricant it stood a 50 pound load on the Timken test but softened abnormally on the beater test. However, the base lubricating grease plus 0.25 per cent glycerol, 0.25 per cent triethanolamine and 3 per cent "Elco SCL" held a 50 pound Timken load without seizure and softened only 27 points on the beater test.

Lubricating Greases Containing Metal Salts of Phosphorus Treated Hydrocarbons

According to Forster and Adams (U.S. Patent 2,859,178, assigned to Esso research and development Co.), mineral lubricating oils or synthetic fluids when thickened with 22 to 60 per cent of metal salts of a phosphorus sulfide treated hydrocarbon form satisfactory bearing lubricants. The metals used include sodium, lithium, calcium, barium, strontium, aluminum or lead. The preferred hydrocarbon which is treated with a sulfide is a bright stock or a related lubricating oil residue.

For example a Mid-Continent bright stock having a viscosity of 170 SUS at 210°F. was treated with 17 weight per cent of phosphorus pentasulfide at a temperature of 400°F. for ten hours. After the reaction product was filtered it was diluted with an oil having a viscosity of 40 SUS at 210°F after which it was neutralized with 30 per cent by weight of barium octahydrate, based on the weight of sulfide-treated hydrocarbon. A series of such mixtures were prepared in which the barium salt content was 15 per cent, 18 per cent, 24 per

cent, 30 per cent and 36 per cent respectively. All of the compositions had dropping points above 500°F. but the worked penetrations varied from semi-fluid with the lowest thickener content to 169 in the mixture containing 30 per cent of barium salt. The last three products exhibited no clouding when boiled with water for ten minutes.

Following the same procedure, a sodium base product was made containing 54 per cent of the salt and 46 per cent of oil. This had a dropping point of 285°F. and unworked penetration of 105. A calcium salt product with 45 per cent of the thickener had a dropping point of 500°F. and an unworked penetration of 140.

Aluminum Soap Thickened Lubricating Greases

Soaps, particularly aluminum soaps made from a mixture of normal high titer fatty acids and 0.5 to 25 per cent of dibasic acids, such as sebacic, when used to thicken lubricating oils, give products of improved worked stability.

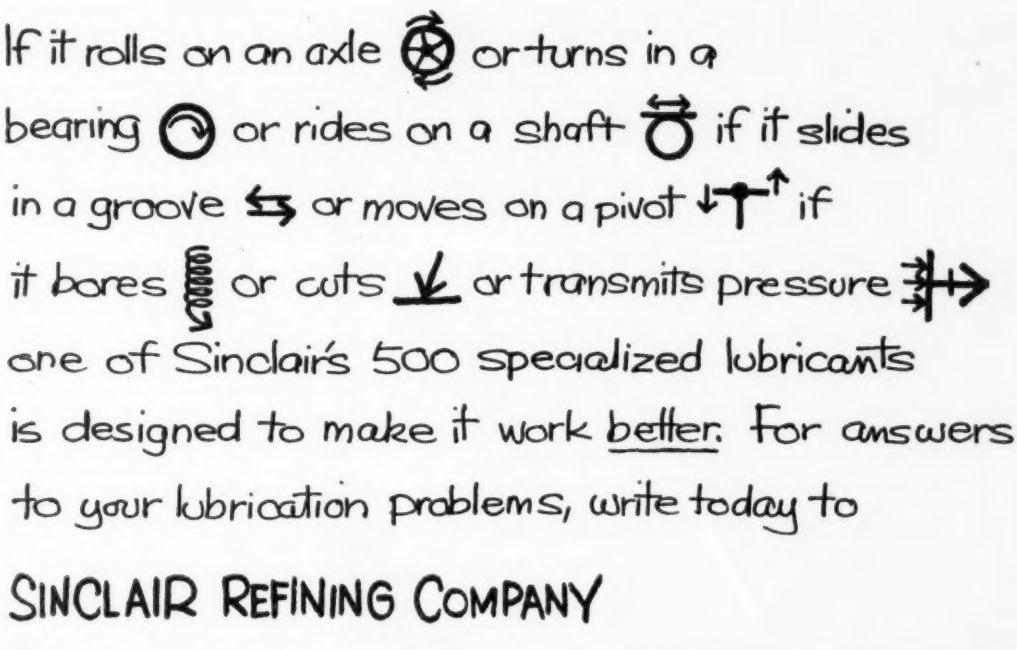
For example, Lux and Parker (U.S. Patent 2,859,179, assigned to Witco Chemical Co.) saponified 95 parts of hyfrogenated herring acids and five parts of sebacic acid with 22 parts of caustic soda in a water solution. Aluminum sulfate was then added in excess until the solution had a pH of 5. A precipitate of aluminum soap was formed which was filtered, washed, dried and ground. Six per cent of this soap, mixed with a Mid-Continent oil of 300 viscosity SUS at 100°F., was heated to 300°F. and after cooling formed a lubricating grease with the following penetrations: unworked 177; worked 60 strokes 284; worked 5,000 strokes 305.

Similar calcium and lithium soaps formed stiffer lubricating greases than did soaps made without the sebacic acid.

Alkali Metal-Lead Soap Base Lubricating Greases

Jordan (U.S. Patent 2,859,180, assigned to The Texas Co.) found that with a certain manufacturing procedure it is possible to form lithium-lead soap base lubricating greases of low soap content. The method consists of first reacting a portion of the total fatty acids or fatty acid esters with lead oxide, cooling the resulting mixture and then forming the lithium soap.

For example, 14.8 pounds of 12-hydroxy stearic acid, 7 pounds of a paraffin oil having a viscosity of 100 SUS at 100°F., 2.2 pounds of water and 1.14 pounds of litharge were reacted at 300 to 330°F. for one hour. After cooling the mixture to 200 to 210°F., 11.2 pounds of 9.9 per cent aqueous solution of lithium hydroxide was added in increments. After heating and mixing at 180 to 210°F. for two and a half hours, the mass was dehydrated at 280 to 330°F. for ten hours during which time an additional six pounds of oil was added. Following dehydration, an additional 44.7 pounds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of oil was added to the mixture while it was slowly cooled with stirring. This gave a lubricating grease containing 15.2 per cent of lithium soap, 5.1 per cent of lead soap, 0.2 per cent of excess lithium hydroxide and 79.5 per cent of oil. This product had an unworked penetration of 191, a worked penetration of 300 and a dropping point of 359°F.

A similar composition, in which the first dehydration step was omitted, had a higher soap content and yet was softer than the product described above.

When a methyl ester of 12-hydroxy stearic acid was used in place of fatty acids, the finished lubricant, even with less soap was lower in penetration.

High Temperature Stabilization of Lubricating Greases Thickened With Inorganic Gels

Peterson, Abrams and Stross (U.S. Patent 2,860,104, assigned to Shell development Co.) find that lubricating greases in which fine silica or clays are the thickener can be stabilized against oxidation or decomposition at temperatures up to 450°F. by including in the lubricant one to 25 per cent of certain hydrocarbons having molecular weights of 300 to 750 together with one half to twenty per cent of zinc oxide, zinc hydroxide, zinc borate, or zinc carbonate.

The high molecular weight hydrocarbons desired may be present in bright stocks and cylinder stocks. Thus, a lubricating grease was made by thickening 90 per cent of Mid-Continent bright stock, which contained sixteen per cent of the desired naphthenic hydrocarbons, with ten per cent of a silica aerogel. A film of this lubricant, approximately 0.012 inch in thickness on a sanded steel plate, was heated for 6 hours at 400°F. in an atmosphere of circulating air. Under these conditions the product oxidized to a hard lacquer.

When the above lubricating grease was modified by the addition of ten per cent of zinc oxide and exposed to the same conditions the film remained plastic and apparently unchanged. Also this combination showed a 200 to 300 per cent increase in cycle life in a bearing at 400°F. over the lubricating grease without the zinc oxide.

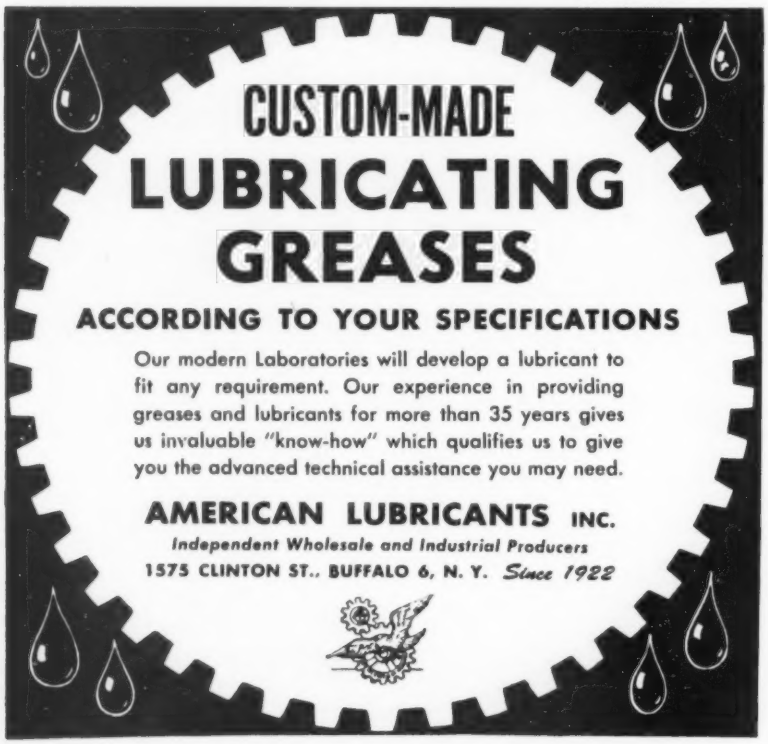
Further, a similar lubricating grease in which ten per cent of fine aluminum oxide replaced the zinc oxide was subjected to the high temperature film test. Under these conditions a hard varnish formed.

Complex Lubricating Grease Thickener Containing an Inorganic Salt

Complex lubricating grease thickeners described by Morway and Kolfenbach (U.S. Patent 2,861,043, assigned to Esso research and engineering Co.) contain, in addition to normal soap ingredients and acetates, nitrates or silicates of the metal used in the complex. While alkaline earth complexes are mentioned the preferred compounds are those of calcium. Such thickeners are prepared by heating to 450 to 600°F.

For example, four parts of Hydrofol acids 51, 3.3 parts of hydrated lime, 5.3 parts of calcium silicate and 82.9 parts of a naphthenic oil having a viscosity of 50 SUS at 210°F. were warmed and mixed at 135°F. Next, four parts of glacial acetic acid were added and heating continued to 500°F. At this point heating was discontinued and the mass was cooled while working to 250°F. where 0.5 parts of phenyl alpha naphthylamine was added. After further cooling to 200°F. the lubricating grease was homogenized to give a smooth product having 0.89 per cent free alkalinity as NaOH and no dropping point. Penetration were, unworked 200, 60 strokes 242, 100,000 strokes 260. The lubricant passed a wheel bearing test at 220°F, for six hours with no separation or leakage. In a Norma Hoffman oxidation test 310 hours were required for a five pound pressure drop.

Such products are satisfactory for use at high temperatures. For example a similar product containing calcium nitrate had a life of 892 hours in a bearing operating at 250°F. and 10,000 rpm.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Mr. Ouer succeeds Mr. Truman W. Floyd. A company vice president, Mr. Floyd has been appointed to the executive committee and will continue to handle all foreign sales with the exception of Canada. Rieke Metal Products corporation has manufacturing plants in Canada and Mexico, and the company's products are manufactured in England by Reads Limited. The company specializes in the manufacturing of steel and plastic closures for steel shipping containers.

Emery Adds Dr. Schneibler and Dr. Huber to Research Staff

Emery Industries has added Dr. Ulrich W. Schneibler and Dr. Clarence F. Huber to its research staff.

A native of Germany, Dr. Scheibler has been with the Diamond Alkali company in Painesville, Ohio, since 1957, prior to which he was with the Schering company in Berlin. At Emery he will conduct fundamental research involving mechanisms and structures of organic compounds in Emery's basic research section.

Dr. Scheibler is a graduate of both the undergraduate and graduate schools of the Techniche Universitat in Berlin, and is a member of the American Chemical Society and Alpha Chi Sigma.

Prior to joining Emery, Dr. Huber was chief chemist at Carlisle Chemical works, and has also been associated with the Lubrizol corporation. He will conduct research on the utilization of Emery's prod-

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ucts for the application research section.

Dr. Huber received his Ph.D. from Case Institute of Technology, M.S. from the University of Illinois, and A.B. from Wabash college. In addition to being the secretary-treasurer of the Cincinnati professional chapter of Alpha Chi Sigma, he is a member of the American Oil Chemists' Society, the American Society for Testing Materials, the American Society of Lubrication Engineers, the Association of Asphalt Paving Technologists, and Sigma Xi.

Girdler Catalysts Names Taylor Research and Development Manager

Appointment of Dr. J. Earl Taylor as manager of research and development was announced by Girdler Catalysts, Louisville, Ky., a unit of Chemetron corporation's Chemical Products division.

Dr. Taylor had been market development manager for Girdler Catalysts since 1954 and will incorporate that function in his new position. He succeeds Dr. John N. Pattison. The announcement was made by Howard D. Hartough, general manager of the specialty catalysts firm, who said that the move frees Dr. Pattison to take charge of a new diversification and long-range research program.

A native of Greenfield, Indiana, Dr. Taylor was graduated from Wittenberg college, Springfield, Ohio, in 1922, received his master's degree in 1924 and doctor's degree in 1927 from Ohio State university. He was an assistant professor of chemistry at Wittenberg between 1922 and 1927.

Following fifteen years of catalyst research work for Proctor & Gamble, Dr. Taylor served as director of research for the gas processes division of the Girdler corporation (later merged with Chemetron Corporation) from 1942 until 1944 when he went on leave to the World War II Manhattan project. Following the war he held positions with E. F. Drew & Co., Boonton, N. J., Dodge Chemical Co., New York, and Markite Co., New York, before returning to Louisville in 1954.

Dr. Taylor has had 13 patents issued. He is a member of the American Chemical Society, the American Oil Chemists Society and Sigma Xi.

Gulf's Refinery Technology Lab Becomes Division of Research and Development

Gulf Oil corporation's refinery technology laboratory at Philadelphia, Pa., has become a division of Gulf research & development company, Gulf's research subsidiary whose principal laboratories are located at Harmarville, Pa.

Although the RTL and its approximately 420 employees will continue to occupy present quarters at Gulf's Philadelphia refinery,

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they have been transferred from the manufacturing department to Gulf Research & Development company.

Paul K. Kuhne, formerly director—refinery technology in Gulf's manufacturing department, has been appointed associate director of research, Gulf research & development company. Mr. Kuhne will have administrative responsibility for the technical service activities of GR&DC, including those carried out by RTL. Mr. Kuhne's headquarters will be at Harmarville. Mr. T. L. Cantrell will continue in Philadelphia as manager of RTL.

Under the new arrangement, the Refinery technology laboratory will continue its present functions. These are primarily to render technical service relating to product and process matters to the manufacturing department and to all other departments of Gulf Oil corporation.

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In announcing the new organizational arrangement, Dr. Blaine B. Wescott and Dr. Jerry McAfee, Gulf vice presidents, also said that studies currently are under way to determine the best long-range location for Gulf's technical service facilities.

Mr. Kuhne, the newly appointed associate director of research, is a veteran of nearly 32 years service with Gulf. He joined the Company in Port Arthur, Texas, as a chemist in June, 1927, shortly after graduation from Tulane university. In 1930 he was transferred to Philadelphia as chief chemist at the refinery there and four years later was made supervisor, refinery technology division. He came to Gulf's Pittsburgh offices in 1941 as assistant to the general manager, manufacturing department. He was named director, refinery technology in 1955.

During World War II, Mr. Kuhne served on a number of committees for the Petroleum Administration for War. In 1945, he was a member of the PAW technical oil mission to Germany.

He is currently active on committees of the American Petroleum Institute and American Society for Testing Materials.

Pure Oil Promotes L. J. O'Brien and M. A. Rosenfeld

Dr. Leo. J. O'Brien and Dr. Melvin A. Rosenfeld have been promoted to become directors of newly created divisions at the Pure Oil company's research center at Crystal Lake, it was announced by Hugh L. Hemmingway, director of research.

Dr. O'Brien was named as director of the production engineering research division and Dr. Rosenfeld as director of the exploration research division.

Dr. O'Brien first became associated with Pure in 1940 as a participant in a co-operative educational project at Northwestern university. After graduating in 1943, he served three years in the Navy. He received his Ph. D. from Northwestern in 1949 and rejoined Pure the same year.

Dr. Rosenfeld, who attended the University of Chicago and Penn State, joined Pure in 1957. He served in the Air Corps in World War II, and for several years has been active in the field of oil exploration research.

A. W. McKee Joins A-D-M

Arthur W. McKee has joined Archer-Daniels-Midland company's New York sales office as a sales representative for commodity oils, it was announced by Paul McClay, ADM assistant vice president and New York regional sales manager.

McKee formerly was a research assistant at the University of New Hampshire, from which he holds a bachelor's degree.

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Industry News

40th Anniversary is Celebrated by Battenfeld of K. C.

Forty years of manufacturing lubricating grease was celebrated in February by the Battenfeld Grease & Oil corporation, Kansas City, Missouri. The company was founded in 1919 by J. R. Battenfeld, a founder of NLGI and president of the company until his death in 1947.

With a limited amount of capital, a small plant was built at 3148 Roanoke Road, Kansas City. In February of that year the first order went out of the plant and Battenfeld entered the young, but growing, lubricating grease industry. Since 1919, the company has been growing continually until today it is considered the leading independent grease manufacturer in the world. The large modern factory has expanded until it now covers the equivalent of several city blocks.

In 1932, the Waterproofing division was added to the company and since that time a complete line of waterproofing and maintenance products, such as caulking compound, roof coatings, screen enamel, and preservative paints, have been manufactured and sold.

The company places heavy emphasis on research to develop new and better products for its customers. Modern research facilities are maintained by both the Waterproofing and Lubricating Grease divisions; laboratory experiments and field tests are constantly being conducted to further this development. To maintain its technical lead in the lubricating grease industry a new research and control laboratory was recently built.

As an example of the changes in the lubricating grease industry since Battenfeld began operations, in 1919, the company had only about a half-dozen formulae. Now, some 3000 formulae are on file, and more are being developed every day.

While Kansas City is the home of the Battenfeld Grease & Oil corporation, a large warehouse branch is located in Minneapolis, Minnesota, and a manufacturing plant in Compton, California.

Officers of the Company are: A. J. Daniel, president; Hugh H. Bruner, exec. vice - president; George W. Krause, vice-president, research and production; Quentin McCabe, treasurer; Charles E. Gore, sales manager, lubricants; and Bob M. Gee, sales manager, waterproof.

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Because Molysulfide's extra tough film of protection bonds firmly to all bearing surfaces, Molysulfide chassis grease can't be squeezed out, jolted out or washed out between lubrications. It stays right in there, fighting friction for a full thousand miles. Want proof? An independent research organization made a 2-year, 2,000,000-mile road test of this new lubricant against a conventional chassis grease. They found that Molysulfide grease reduced wear on critical auto parts from 17 to 53%.

When customers ask your service stations for Molysulfide grease jobs, it pays to be ready for them.

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Petroleum Packaging Committee Announces New Officers and Reports New Developments

The members of the Petroleum Packaging committee, in a regular meeting at Detroit on February 16 and 17, elected new officers for the year, 1959. These are:

Mr. Robert Rutherford, Sun Oil company, Philadelphia, Pennsylvania, Chairman

Mr. L. E. Stuart, Continental Oil company, Houston, Texas, Vice Chairman

Mr. Milton Weichbrodt, Standard Oil company (Ind.), Chicago, Illinois, Secretary-Treasurer

Appointments made to various committees and subcommittees by the chairman were as follows:

Mr. Charles Fricken, Socony-Mobil as liaison with API and NLGI

Mr. Henry Marymont, West Penn Oil company as liaison with Packaging Inst.–Closure committee

Mr. I. N. Wade, Gulf Oil company as general chairman of shipping subcommittees

Mr. G. R. Bellville, The Texas company as chairman New Packaging Materials subcommittee

Mr. Joe Scully, Shell Oil company as liaison with Manufacturing Chemists association

The Shipping Case subcommittee reported that a permit had been received from the Classification committee of the American Railroads association to make test shipments of cases made with the gap-flap construction. Cases are to have a three-inch space between flaps on the top and a 2-inch space between flaps on the bottom with all of the flap area glued. Test shipments will be permitted for six months beginning February 4, 1959. No permit has yet been received from the Trucking association.

The Metal Drum and Pail subcommittee reported that their studies show that the present location of the bead on five gallon and 35 lb. pails is ineffective. This bead does not give added strength to the pail bodies. They made exhaustive tests which indicate that the pails should have at least two beads and these should be located three to four inches from either end of the pail body. These beads not only give added strength to the pail but also act as a preventative measure to keep the pails from collapsing if products are filled at an extremely high temperature.

This subcommittee also reported that tests are underway on lightweight metal 120 lb. drums of 24 and 26 gauge steel. Tests are also being made of 120 lb. drums made from fibre.

This subcommittee reported that a careful review of the present specifications for 55 gallon universal metal drum shows that this drum is the most economical from the standpoint of conservation of material and also shipping space.

The committee adopted rules of operation which have been under study for many months. These have been finalized and were submitted to the committee by a subcommittee of which Dr. P. S. Nisson, Pure Oil company of Chicago, was chairman.

Announcement was made by Mr. R. Chester Reed, historian, that copies of the history of the first nine years of the committee's activities could now be secured from the Packaging Institute.

The Small Metal Packages subcommittee reported on a standard for metal tubes. This standard was adopted by the committee.

Other meetings scheduled for 1959 are as follows:

Cleveland, Ohio, in conjunction with the Materials Handling Association's exposition, June 8 and 9.

Port Arthur, Texas, October 12 and 13.

T. F. Shaffer Gives Joint Container Committee Report

Given below is the Joint Container committee report to the API Lubrication committee and the NLGI Board of Directors, by T. F. Shaffer of Shell Oil. Mr. Shaffer is chairman of this committee for NLGI:

The Petroleum Packaging Committee met February 16-17 in Detroit. The following summarizes highlights of the meeting.

1. *The Use of Lighter Gauge Steel in Packages.*

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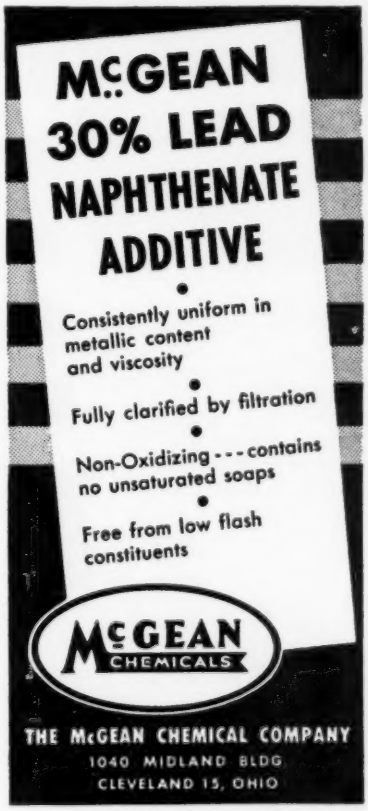

a. 55 *Gal. Drums.* Transportation of 20/18 gauge 17E drums was approved December 5 by the Motor Carriers association, and December 8 by the Railroad Freight Classification committee. The PP is now trying to get similar approval for shipment of gear oil in 20/18 gauge 400 lb. FOH drums; five companies have test permits for such shipments, and Socony reports good results.

b. 120 *LB. L. C. Drums.* The American Standards association standard drum is 20 gauge. Socony has permit for test shipments of 24 gauge 120 lb. drums; they think 26 gauge unsatisfactory, but 26/24 gauge may be satisfactory for domestic shipments.

c. 5 *Gal. Pails.* PPC has interesting results on the effect of bead location on strength of pails. The ASA standard is 24 gauge. But 28 gauge pails with two sharply located beads are stronger than the standard 24 gauge pail. The optimum bead location is three inches to four inches from the top and bottom. Revisions in the standard are being worked out in cooperation with the Steel Shipping Container Institute.

2. *Increased Economy and Efficiency in Shipping Cases for Quart Cans.* PPC is investigating (1) the practicality of using gap-flap cases, (2) whether or not it would be desirable to change from present rectangular-pack to diagonal-pack cases, (3) standardization of the method of measurement of inside dimensions of shipping cases, so as to obtain tighter can packs for less damage in shipment, and (4) the use of non-skid coatings.

3. *Petroleum Packaging Industry Advisory (Government) committee.* The committee advises (1) no satisfactory substitute has been found for olive drab paint, (2) gasket material is still causing contamination of package contents, (3) impact-extruded aluminum cans are being tested for turbine oil, and (4) the Military Petroleum Supply agency is working through NATO for international standardization of ASA standard drums and cans.

4. *Miscellaneous.* Continental Can's 120 lb. fiber drum is reported reasonably satisfactory for grease, but questionable for gear oil. The new 5-gallon utility can is gaining commercial acceptance. PPC has added a Traffic Sub-Committee to its subcommittee list. Work is continuing on standardization of wax packaging, asphalt packaging, etc. The new chairman of PPC is Mr. Robert Rutherford, of Sun Oil company. PPC will welcome any comments or suggestions from the Lubrication committee or NLGI.

Emery Offers New Edition of Catalog

Emery Industries offers a new edition of its catalog, listing product designations, descriptions, and specifications for Emery's line of organic chemicals. Included for the first time are the metholene fatty acid esters, as well as other individual products that have been added during the past year. Other organic chemicals that are covered in the brochure are empol dimer acid, emerox azelaic acid, emfac pelargonic, capric, and caprylic acids, emolein esters for synthetic lubricants, plastolein plasticizers, twitchell fat splitting reagent, and twitchell and emersoft textile chemicals.

For a copy of the brochure, write Emery Industries, Inc., Dept. 5, Carew Tower, Cincinnati 2, Ohio, and request "Specifications and Characteristics of Organic Chemicals."

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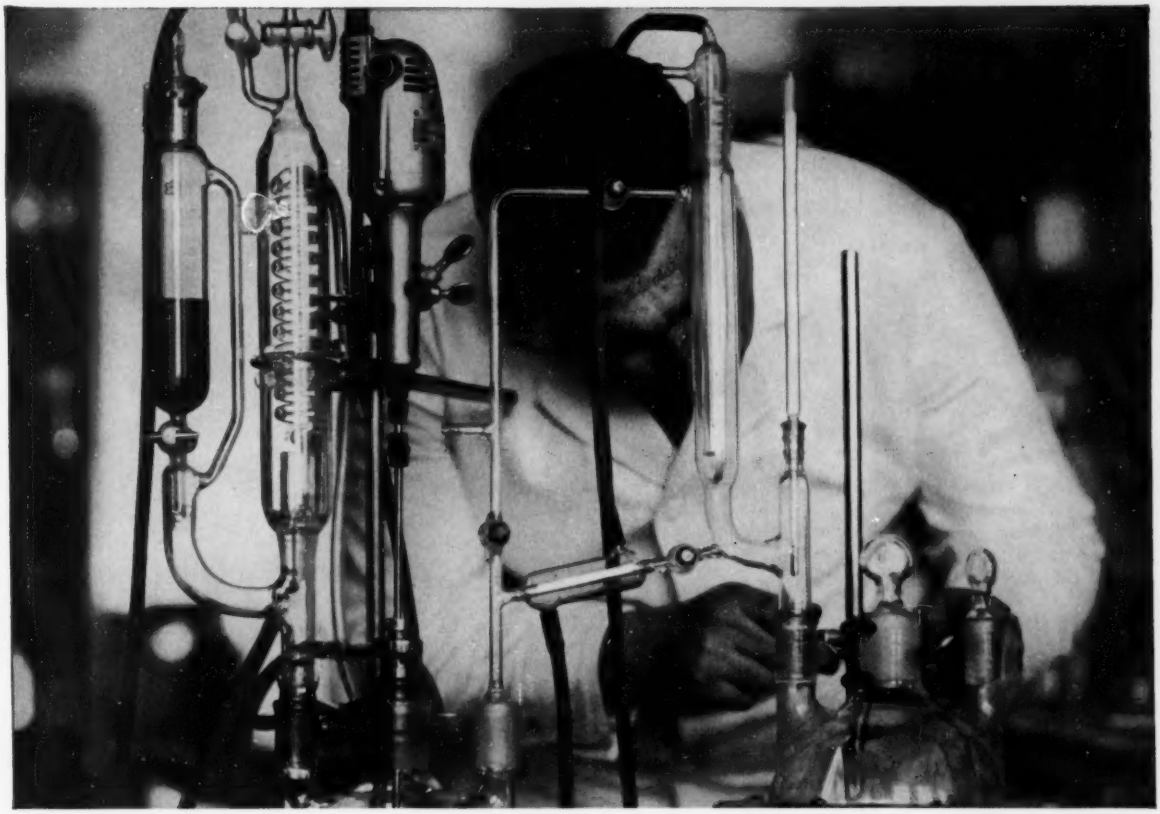

How organic chemists put lithium to work

Recent interest in organolithium compounds owes much to the fact that these compounds are soluble in hydrocarbons. The reactions of the organolithium compounds resemble those of organomagnesium compounds, yet have distinct advantages. In solution, lithium compounds exhibit a degree of reactivity intermediate between alkali and magnesium reagents.

Where it is necessary to use ether solvents, it is found that organosodium compounds decompose most ethers too rapidly. The organomagnesium compounds have too slow a reaction rate to be useful. With organolithium compounds the desired reaction can be completed before the ether is substantially attacked.

To produce intermediates for further reaction, certain ethylenic and aromatic systems add lithium and other alkali metals to give metallic derivatives. Lithium appears to react more readily than sodium or potassium and sometimes follows a different course of reaction.

Lithium metal and lithium alkyls seem to have the ability to direct the course of a polymerization. Isoprene has been polymerized to a product containing over 93% cis-1,4 addition product. Such polymers are considered to be the nearest approach to natural rubber. This stereospecific behavior of lithium catalysts may be useful in other organic reactions.

Reduction by means of alkali metals can be accomplished by using sodium in high-boiling solvents and in liquid ammonia. Recently it has been reported that the use of lithium often gives better yields. The versatility of lithium as a reducing agent in ethylenic and aromatic compounds is shown by the selective reduction of the carbon-carbon double bond of a conjugated ethylenic ketone using lithium in liquid ammonia. A contrasting example is the selective reduction of the carbonyl group of an unsaturated ketone using lithium aluminum hydride.

But this is only the beginning. Though the information on lithium in organics is relatively limited, its vast potential in this field is already well established. We'll be glad to share this information with you if it can help you in any way with your specific organic problem. Address letterhead request to Technical Literature Department, Foote Mineral Co., 402 Eighteen W. Chelten Bldg., Phila. 44, Pa.

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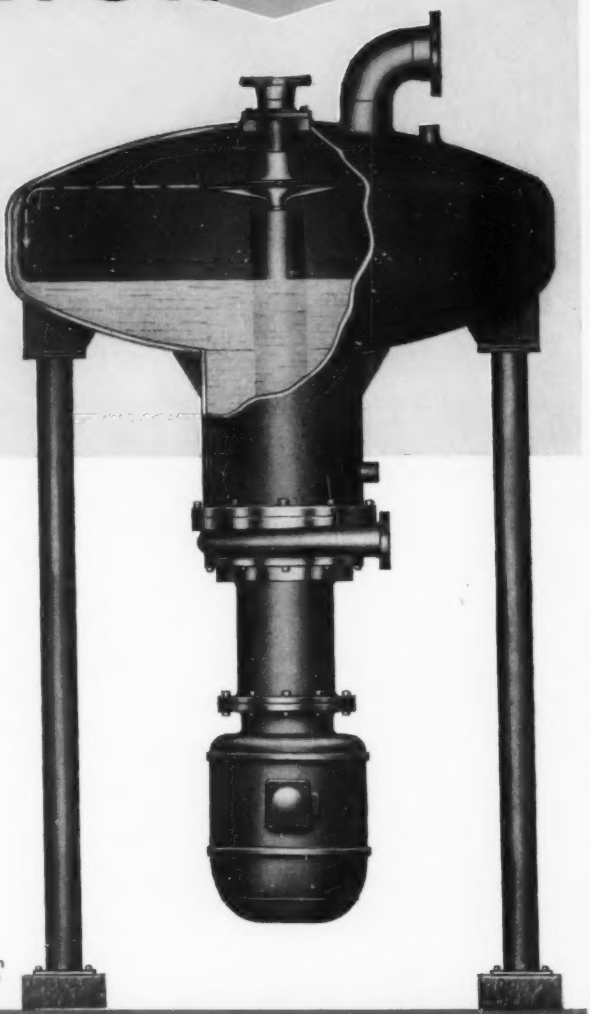

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